SPURRING ECONOMIC GROWTH AND COMPETITIVENESS THROUGH NASA-DERIVED TECHNOLOGIES

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE AND AERONAUTICS

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

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SPURRING ECONOMIC GROWTH AND COMPETITIVENESS THROUGH NASA–DERIVED TECHNOLOGIES

THURSDAY, JULY 12, 2012

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE AND AERONAUTICS,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:00 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Steven Palazzo [Chairman of the Subcommittee] presiding.

RALPH M. HALL, TEXAS
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U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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Subcommittee On Space and Aeronautics

Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Thursday, July 12, 2012
10:00 a.m.-12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Dr. Mason Peck, NASA Chief Technologist
Mr. George Beck, Chief Clinical and Technology Officer, Impact Instrumentation, Inc.
Mr. Brian Russell, Chief Executive Officer, Zephyr Technology
Mr. John Vilja, Vice President for Strategy, Innovation and Growth, Pratt & Whitney Rocketdyne
Dr. Richard Aubrecht, Vice President, Moog, Inc.

SUBCOMMITTEE ON SPACE AND AERONAUTICS
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Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Thursday, July 12, 2012

10:00 a.m. – 12:00 p.m.
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Purpose

NASA is often considered an incubator for technology development, and history has shown a vast array of technologies that owe their start to NASA programs. Despite decades of demonstrated success, federal investment in NASA remains essentially flat even as other R&D agencies are seeing increases. Furthermore, investment in NASA's technology transfer activities has seen a drastic decline in recent years.

The purpose of this hearing will be to examine the direct economic and societal benefits that investments in NASA have generated and highlight those areas where continued investments could help stimulate the pipeline for future economic growth.

Witnesses

- **Dr. Mason Peck,** NASA Chief Technologist
- **Mr. George Beck,** Chief Clinical and Technology Officer, Impact Instrumentation, Inc.
- **Mr. Brian Russell,** Chief Executive Officer, Zephyr Technology
- **Mr. John Vilja,** Vice President for Strategy, Innovation and Growth, Pratt & Whitney Rocketdyne
- **Dr. Richard Aubrecht,** Vice President, Moog, Inc.

Background

The National Aeronautics and Space Act of 1958 established NASA as the leading agency for aeronautical and space sciences, and specifically directed that the new agency would "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."[1] Since then, NASA has developed innovative technologies that are ubiquitous to daily civilian and military life in the United States – and even the world. Besides

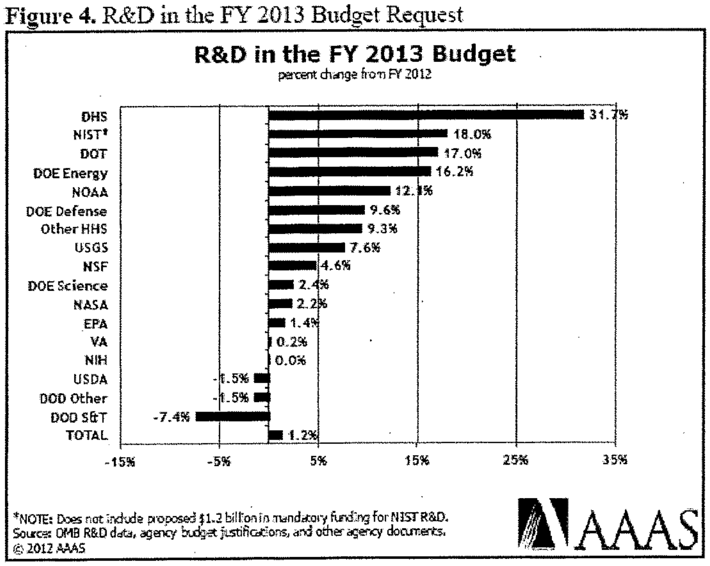
[1] http://history.nasa.gov/spaceact.html

being the global leader in advanced aircraft and spacecraft design, NASA technologies have paved the way for advances in the medical field, environmental stewardship, and public safety.

The Stevenson-Wydler Technology Innovation Act of 1980 and the Federal Technology Transfer Act of 1986 also support NASA's technology transfer activities. Each mandate the promotion of federally-funded research and technology transfer to the commercial sectors, and state and local governments. They also grant authority to Government-owned and Government-operated laboratories to enter into cooperative research and development agreements with the private sector and with academia.

On October 28, 2011, President Obama issued a memorandum entitled, "*Accelerating Technology Transfer and Commercialization of Federal Research in Support of High Growth Businesses*," requiring all Federal agencies to identify opportunities for, and plan transitions to, increase the number of technology transfer and commercialization activities.[2] As the chart below demonstrates, however, funding for research and development at NASA is barely keeping pace with inflation – even as other agencies are reaping the benefits of increased investments.

Figure 4. R&D in the FY 2013 Budget Request



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[2] http://www.whitehouse.gov/the-press-office/2011/10/28/presidential-memorandum-accelerating-technology-transfer-and-commerciali

[3] AAAS Report, Federal Research &Development FY 2013, p. 14

It should be noted that the FY 2013 budget request for the Space Technology Directorate was $699 million, an increase of $125.3 million. The SBIR and STTR programs are required by federal law to represent a base percentage of R&D (currently 2.7% for FY 2013). The Partnership Development and Strategic Integration Program – central to carrying out the agency's technology transfer and commercialization efforts – would receive only $29.5 million.

	Actual	Estimate		Notional			
Budget Authority (in $ millions)	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**FY 2017**
FY 2013 President's Budget Request	456.3	573.7	699.0	699.0	699.0	699.0	699.0
SBIR and STTR	164.7	166.7	**173.7**	181.9	187.2	195.3	206.0
Partnerships Dev & Strategic Integration	25.6	29.5	**29.5**	29.5	29.5	29.5	29.5
Crosscutting Space Tech Development	120.4	187.7	**293.8**	272.1	266.6	259.7	247.0
Exploration Technology Development	144.6	189.9	**202.0**	215.5	215.7	214.5	216.5

Office of Chief Technologist

The Office of Chief Technologist (OCT) manages NASA's Space Technology programs and coordinates and tracks all technology investments across the agency. The office is also the primary point of contact with other government agencies and outside entities and is responsible for managing innovative technology partnerships, technology transfer and commercial activities. There are four programs that support the transfer of technology:

- The Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) Programs – which apply to all federal departments and agencies - were established by Congress in 1982 to aid small and disadvantaged businesses to partner with federally funded research and development programs.
- The Crosscutting Space Technology Development Program focuses on developing capabilities that advance future space missions.
- The Exploration Technology Development Program focuses on advancing the development of technologies to enable human missions.
- The Partnership Development and Strategic Integration Program provides for the transfer and commercialization of NASA-developed technologies, coordinates interagency technologies, and manages intellectual property rights. This program also seeks out opportunities for partnership with other government agencies and industry.

While the first three of these programs seek to identify and develop technologies specifically to meet agency mission objectives, the fourth program seeks to push NASA-derived technology out into the private sector. The Innovative Partnerships Office (IPO), part of the Partnership Development and Strategic Integration Program, seeks to promote innovative partnership opportunities to commercialize technology that can be transferred from NASA's programs and projects. Each NASA Center also has an IPO and a Chief Technologist that work directly with OCT.

It should be noted that the SBIR/STTR programs – while focusing on technologies that can be infused into NASA's missions – have consistently yielded spinoff technologies into the private sector. As a result, approximately 30% of all spinoff technologies reported by NASA over the last decade can be attributed to SBIR/STTR partnerships.

NASA Inspector General Report on Technology Transfer

In March 2012, the NASA Inspector General issued an *Audit of NASA's Process for Transferring Technology to the Government and Private Sector.* The report concluded:

> NASA has missed opportunities to transfer technologies from its research and development efforts and to maximize partnerships that could provide additional resources, and industry and the public have not fully benefited from NASA-developed technologies.[4]

For example, the primary tracking mechanism for reporting potentially transferrable technologies is through New Technology Reports (NTRs). NTRs are submitted by NASA employees and contractors who develop new technologies and are reviewed by the IPO and Patent Counsel to determine their technical merit. But as the table below highlights, NASA's ability to adequately process NTRs and consequently move promising technologies forward has been declining. The table notes that despite having over 1,800 NTRs filed in FY 2011, the number of patents filed was only 82 (contrasted to FY 2004 when only 585 NTRs were submitted yielding 131 filed patents).

Table 3. NASA NTR and Patent Filing Status at the End of Each Fiscal Year and Fiscal Year Technology Transfer Funding Levels

Fiscal Year	Cumulative NTRs under Evaluation	Cumulative NTRs Awaiting/ Preparing Patent Application	Patent Application under Prosecution	Patent Filed	Technology Transfer Funding (million)
2004	585	6	20	131	$60.00
2005	654	6	28	135	$45.30
2006	725	7	41	127	$38.25
2007	844	11	81	109	$26.60
2008	1,017	14	140	117	$38.10
2009	1,493	26	322	115	$23.60
2010	1,504	30	296	98	$20.54
2011	1,878	34	372	82	$20.54

[4] *Audit of NASA's Process for Transferring Technology to the Government and Private Sector,* IG Report No. IG-12-013, March 1, 2012, p. iv

As demonstrated above, the percentage of NASA's overall budget for technology transfer funding has steadily declined. According to the NASA IG:

> Since fiscal year 2004, funding for NASA's technology transfer efforts has decreased by 68 percent, from $60 million in 2004 to $19.2 million in FY2012 [from within the Partnership Development and Strategic Integration funding line]. In addition, personnel resources dedicated to the technology transfer effort have similarly declined. For example, since FY 2003 the number of patent attorneys at the Centers has dropped from 29 to 19 and Headquarters IPO staff has decreased from 13 in FY 2010 to just 2 in FY 2012.[5]

The IG provided recommendations to the NASA Chief Technologist to improve NASA's technology transfer and commercial efforts. Specifically, the Chief Technologist should:

- Implement procedures to ensure appropriate personnel are held accountable to the [NASA] requirements
- Provide relevant periodic training to NASA personnel
- Reassess the allocation of resources for technology transfer
- Coordinate with the Chief Engineer to ensure NASA Policy Requirements emphasized the importance of developing Commercialization Plans
- Coordinate with the General Counsel to ensure NTRs are accessible to NASA project managers and innovators as appropriate

The Chief Technologist concurred with the IG recommendations and is currently undergoing evaluations and implementing changes to improve the policies governing technology transfer and the training necessary to ensure Agency employees and contractors are following procedures to maximize effectiveness.

NASA Spinoffs

NASA defines a spinoff as "a commercially available product, service or process that takes NASA-related technology and brings it to a broader audience."[6]

Since 1976, NASA has documented successful examples of technology transfer and commercialization in its annual *Spinoffs* publication. Over 1,750 case studies have demonstrated the tremendous economic and societal benefits that have been generated in fields as diverse as computer technology, manufacturing, health and medicine, public safety, consumer goods, and energy conversion and use.

Examples from the most recent publication, *Spinoffs 2011* include:

- ***Impact Instrumentation, Inc., West Caldwell, New Jersey***. Drawing on the expertise of Johnson Space Center space medicine experts under the auspices of a Space Act Agreement, Impact Instrumentation Inc. made advances in medical ventilator technology

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[5] IG Report No. IG-12-013, March 1, 2012, p. iii
[6] *Spinoff 2010*, Forward, p. 7

now incorporated into emergency medical solutions for soldiers and civilians around the world.

- ***Zephyr Technology, Annapolis, Maryland:*** Through a Space Act Agreement with *Ames Research Center*, Zephyr Technology worked with NASA physiology experts on motion sickness experiments, resulting in improvements to the company's wearable vital-sign monitors. Zephyr's monitors are now used to monitor the health and fitness of soldiers, first responders, pro athletes, and average consumers looking to get in shape. The company sells thousands of its U.S. manufactured NASA-enhanced products each month.
- ***Pratt & Whitney Rocketdyne, Canoga Park, California***: The Space Shuttle Main Engine was designed under contract to NASA by Rocketdyne, now part of Pratt & Whitney Rocketdyne (PWR). After working with *Marshall Space Flight Center*, PWR used its rocket engine experience to make clean energy gasification technology with 10-20 percent lower capital costs and a 10-percent reduction in carbon dioxide emissions, compared to conventional technology.

NASA's Technology Commercialization Policy

NASA has established formal procedural requirements for technology commercialization. Accordingly, NASA project managers must consider commercialization potential early in the project's life cycle and, where appropriate, develop a Technology Commercialization Plan and strategy for achieving that potential. The policy outlines considerations for the commercialization plan, including pursuing partnerships, cooperative agreements and Space Act Agreements. In addition, the policy requires that new technologies and inventions and resulting success stories must be reported.

The policy provides specific and detailed guidance to NASA program and project managers related to formulating, approving, implementing, and evaluating their technology commercialization activities. Specifically, "NASA managers are challenged to use their expertise and apply innovative techniques to ensure that the technological assets (technologies, innovations, facilities and expertise) from their activities have maximum commercial application."[7]

[7]NASA Procedural Requirements 7500.1, "NASA Technology Commercialization Process w/Change 1 (4/9/04)" http://nodis3.gsfc.nasa.gov/npg_img/N_PR_7500_0001_/N_PR_7500_0001_.pdf, p. 9-10

Chairman PALAZZO. The Subcommittee on Space and Aeronautics will come to order.

Good morning. Welcome to today's hearing entitled "Spurring Economic Growth and Competitiveness through NASA–Derived Technologies." In front of you are packets containing the written testimony, biographies and Truth in Testimony disclosures for today's witness panel. I recognize myself for five minutes for an opening statement.

I would like to begin by thanking our witnesses for taking time from their busy schedules to appear before us this morning and share their insight about the role NASA has played in spurring technologies that yield economic growth and keep America at the forefront of global technological competitiveness. I realize you and your staff devoted considerable time and effort preparing for this hearing, and I want you to know that your expertise will help inform this Committee and Congress during the coming months and years.

In the public media, discussions of NASA's general contributions to society are often distilled down to Tang and Teflon. Yet NASA-derived technologies have paved the way for innovative advances in the medical field, environmental stewardship and public safety. Today's hearing will only skim the surface in highlighting the direct economic and societal benefits investment in NASA has generated.

Since 1976, NASA has documented well over 1,700 successful examples of technology transfer and commercialization. But despite decades of demonstrated success, NASA's budget has remained essentially flat even as other R&D agencies are seeing increases. Investment in NASA's technology transfer activities, however, has seen a drastic decline in recent years.

A recent NASA Inspector General audit on NASA's technology and commercialization efforts concluded that NASA has missed opportunities to transfer technologies and that industry and the public have not fully benefited from the NASA-developed technologies. The IG found a general lack of awareness among NASA program managers about the technology transfer and commercialization process and that many personnel did not understand the range of technologies that could be considered as technological assets. Furthermore, the report found that the number of patent attorneys and dedicated Innovative Partnership Office staff and related funding was insufficient given the technology transfer and commercialization potential. The IG recommended NASA implement a review of the policy process and implement new procedures and training requirements to ensure NASA personnel were fully aware of the process and their responsibilities. The IG also recommended that NASA reassess the allocation of resources for technology transfer. This Committee will follow closely NASA's implementation of these recommendations.

The IG report took a look at formal NASA processes in place, but it begs the question: does technology transfer happen in other, informal ways? And if so, how can NASA best marry entrepreneurs with the technologies it has already developed or those that it may still need for future missions? Exploring both traditional and non-traditional means for technology transfer to the private sector is equally important if we hope to leverage space technology development as an engine for economic growth and U.S. competitiveness.

Today's hearing will explore positive examples of partnerships between NASA and the private sector yielding American-made technologies beneficial to both NASA's space exploration mission and to society as a whole. We will also examine what strategies and programs NASA uses to disseminate technology into the private sector and identify the greatest challenges the private sector has in working with NASA to more quickly transition ideas into new products.

I look forward to today's discussion, and wish to again thank our witnesses for their presence.

[The prepared statement of Mr. Palazzo follows:]

PREPARED STATEMENT OF SUBCOMMITTEE CHAIRMAN STEVEN M. PALAZZO

I would like to begin by thanking our witnesses for taking time from their busy schedules to appear before us this morning and share their insight about the role NASA has played in spurring technologies that yield economic growth and keep America at the forefront of global technological competitiveness. I realize you and your staff devoted considerable time and effort preparing for this hearing, and I want you to know that your expertise will help inform this Committee and Congress during the coming months and years.

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Chairman PALAZZO. I now recognize Mr. Costello for an opening statement.

Mr. COSTELLO. Mr. Chairman, thank you, and thank you for calling the hearing today. I have a brief opening statement which I will enter into the record so that we can hear from the witnesses.

Thank you.

[The prepared statement of Mr. Costello follows:]

Good morning and thank you Mr. Chairman, for calling this important hearing on NASA spinoffs.

NASA technologies produce direct economic and societal benefits for all Americans. Since the agency was established in 1958, technical challenges of NASA's space exploration, space science, and aeronautics missions have led to technological advances, unique skills, and scientific knowledge that have contributed to America's capacity for innovation and global competitiveness.

Mr. Chairman, this hearing serves as an opportunity to educate the public on the connection between the federal government's investments in space and the benefits to society. These contributions developed important products, such as satellite radio, medical diagnostics and aeronautical advances that have improved the safety, and fuel-efficiency performance of both commercial and military aircraft.

In carrying out its missions and developing these technologies, NASA also has inspired young people to enter educational and career paths in science, technology, engineering, and mathematics.

I look forward to hearing from the witnesses on what steps can be taken to enhance NASA's technology transfer and commercialization processes, how to increase the impacts of NASA-applied technologies to the economy and society at large, and ways to improve NASA's communication to the public to ensure the societal benefits of its technology and R&D are better understood and appreciated.

Chairman PALAZZO. Thank you, Mr. Costello.

If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

At this time I would like to introduce our panel of witnesses and we will proceed to hear from each of them in order.

Our first witness is Dr. Mason Peck. Dr. Peck is Chief Technology Officer for the National Aeronautics and Space Administration, where he serves as the agency's principal advisor and advocate on matters concerning technology policy and programs. Prior to joining NASA, Dr. Peck was Associate Professor in the School of Mechanical and Aerospace Engineering at Cornell for eight years. He earned his Ph.D. in aerospace engineering at the University of California at Los Angeles. Dr. Peck has a broad background in aerospace technology, which comes from nearly 20 years in industry and academia.

Our next witness is Mr. George Beck, Chief Clinical and Technology Officer for Impact Instrumentation Incorporated, where he is responsible for the conceptualization and development of new critical-care medical devices. He previously worked for Wyle Laboratories at the Johnson Space Center, where he led a team of scientists and engineers on work to develop a new generation of medical equipment for use on the International Space Station and space shuttle.

At this time I would like to yield to the gentlewoman from Maryland, Ms. Edwards, who will introduce our next witness.

Ms. EDWARDS. Thank you very much, Mr. Chairman and to our Ranking Member. It is a really great privilege to be able to introduce Brian Russell, who is the CEO and founder of Zephyr Technology in Annapolis, Maryland, and just to give you a little bit of background, Mr. Russell received his bachelor's of engineering degree from Auckland University in New Zealand is a subject-matter expert in analog and electronics communications and physiology. He holds three patents and several more provisional applications in the area of physiological sensing using smart fabric sensors. Zephyr Technology is headquartered in Annapolis, has investors like Motorola, 3M, and investors that understand government and business, and employs 35 people at Zephyr and is a global leader in the art and science of remote physiological status monitoring, or PSM. I am delighted to be able to welcome Brian Russell to the Committee today, and know that we are proud, as all of our states are, in Maryland the kind of relationship that has developed between the private sector and the public sector and the innovation and technology exhibited by Mr. Russell and by Zephyr Technology and welcome his testimony today.

Thank you, Mr. Chairman.

Chairman PALAZZO. Thank you, Ms. Edwards.

Our next witness is Mr. John Vilja, Vice President for Strategy, Innovation and Growth at Pratt and Whitney Rocketdyne. Mr. Vilja has enjoyed a 28-year career with Rocketdyne and was most recently the Vice President and Program Manager for the J–2X Earth Departure Stage Engine Program for NASA's Space Launch System. He earned his bachelor's degree in mechanical engineering from California State University-Northridge and an M.B.A. degree from the Anderson Graduate School of Management at the University of California in Los Angeles.

Our final witness is Mr. Richard Aubrecht, Vice President of Moog Incorporated. Dr. Aubrecht has spent the bulk of his 40-year career at Moog after having earned his B.S., M.S. and doctorate degrees in mechanical engineering from Cornell University.

Welcome to you all. As our witnesses should know, spoken testimony is limited to five minutes each. After all witnesses have spoken, Members of Committee will have five minutes each to ask questions.

I now recognize as our first witness, Dr. Mason Peck, for five minutes to present his testimony.

STATEMENT OF DR. MASON PECK, CHIEF TECHNOLOGIST, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. PECK. Chairman Palazzo, Ranking Member Costello and Members of the Committee, thank you for the opportunity to testify on NASA's technology transfer and commercialization efforts and how investments in cutting-edge research and development efforts such as those seen through space exploration can benefit the entire Nation.

On a personal note, I am honored to be serving as NASA's Chief Technologist. As the NASA Administrator's top advisor on technology, I am responsible for a number of things, and that is guiding strategic agency investments in technology, facilitating technology transfer, partnerships in commercialization activities across the agency, advocating externally on behalf of NASA's R&D programs, demonstrating and communicating societal impacts of NASA technology investments, and overseeing executive management of NASA'S Space Technology Program.

As we seek to achieve our national objectives in human space, exploration, aeronautics and scientific discovery, we share with the public the technical advancements we make so that our Nation may benefit from these new ideas in other areas such as efficiencies in manufacturing, advanced medical procedures and protocols, increased agricultural yields and cleaner, safer transportation.

NASA's innovations also stimulate the growth of our innovation economy. Knowledge provided by weather and navigational spacecraft, efficiency improvements in both ground and air transportation, supercomputers, solar- and wind-generated energy, improved biomedical applications including advanced medical imaging as well as the protective gear that keeps our military, firefighters and police safe, all of these have benefited from our Nation's investments in aerospace technology.

NASA provides America with unique capabilities because we take on extraordinarily difficult problems in technology and science. By taking humans to inhospitable places, we learn key survival skills, and about keeping people healthy when the nearest hospital is days away. This translates into benefits like the advanced ultrasound devices created in partnership with NASA: Henry Ford Hospital in Detroit and the company Epiphan in Springfield, New Jersey. Using a portable ultrasound machine, a non-physician can, with minimal technical know-how, send medical imaging from remote locations for consultation with experts. This device is now employed by emergency medical personnel around the country, as well as by coaches and sports teams. This is one of hundreds of examples of how solving technical problems in aerospace also leads us to invent technologies that make life better right here on Earth. It is a single example but it is one of nearly 2,000 that NASA has collected in its annual spin-off publication and I will be glad to provide examples of that publication to you.

I have also brought with me a couple of other examples of very compelling spin-offs—we have got them right here—products derived from NASA technology. So first let me point out this. It is called the Rescue Pod. It increases blood flow to the brain and heart during CPR. It doubles systolic blood pressure and increases survivability. It is used by our armed forces overseas and our EMS units around the country. It was designed as an emergency contingency device to regular blood flow of astronauts transitioning from the reduced gravity environment of space back to earth's gravity but now it saves lives and it came from space.

I have to talk about Micro-Bac, and there is a couple samples here of sand. Both of them were taken from the Gulf shores are the Deepwater Horizon oil-rig spill. One was treated with a solution developed by NASA through our SBIR program. That's the Small Business Innovation Research Program. Marshall Space Flight center in Alabama and Micro-Bac International of Round Rock, Texas, developed a phototropic cell for water purification in space. Inside the cell are millions of photosynthetic bacteria. That formulation is now used for the remediation of wastewater systems and waste from livestock farms and food manufacturers but strains of that same SBIR-derived bacteria also feature microbial solutions that treat environmentally damaging oil spills from the dirty sands right here to the clean sand that I have got in front of me.

And then my cell phone. Most of us have one of these. I am holding up a standard smartphone here, and I am not about to tell you that NASA invented the cell phone but NASA did bring you the cell phone camera right in there. One of our inventors, Eric Fossum out of the Jet Propulsion Lab in California, designed and developed that CMOS camera on a chip that drove the prices of digital imaging sensors low enough that modern cell phones now have camera-quality capabilities. It is a particularly striking example because NASA technology finds its way into our pockets.

So NASA technology is all around us. It is making our lives better, and we have hundreds of these stories to share. We do this through our annual spin-off publication. It is a longstanding NASA tradition where the agency publishes a report on some of these annual technology successes.

Let me move on to talk about NASA's commitment to tech transfer. We have added technology transfer to the top-level agency-wide performance goals that are reported annually to the Office of Management and Budget. We do have room for improvement, though. You mentioned the IG report. They concluded that we lack—or NASA personnel lack awareness of the agency's technology transfer policy requirements; assets aren't consistently identified or fully understood; innovators lack awareness of new technology reporting processes, and new reports are inaccessible. NASA agrees with these findings and we are taking advantage of that report to make improvements in the program. I have got a number of things I can offer here but my time is about up.

So in closing, let me offer you a couple of final thoughts. We are discussing today NASA's considerable success in tech transfer and commercialization but we have to remember that these great spin-offs rely on NASA having an ongoing, robust investment in research and technology. If we don't create new technologies, we will have no new transformational capabilities, new industries, new economic growth and jobs or tech transfer as a result of all those. This is why continued investment by America in research and technology programs such as NASA's Space Technology Program is essential.

Mr. Chairman, thank you for your support and that of the Committee. I would be pleased to respond to any questions you or the other Committee Members may have.

[The prepared statement of Dr. Peck follows:]

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July 12, 2012

Statement of
Dr. Mason Peck
Chief Technologist
National Aeronautics and Space Administration

before the

Subcommittee on Space and Aeronautics
Committee on Science, Space and Technology
United States House of Representatives

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to testify on NASA's technology transfer and commercialization efforts and how investments in cutting-edge research and development endeavors such as those seen through space exploration benefit the entire Nation. With the FY 2013 President's budget request for NASA, America is moving forward with an ambitious program of space exploration that builds on new technologies as well as proven capabilities as we expand humanity's reach into the solar system. While reaching for new heights in space, NASA is creating new jobs right here on Earth, especially for the next generation of American scientists and engineers, by supporting cutting–edge innovations in aeronautics and space technology research and development that will help fuel the Nation's economy for years to come.

On a personal note, I am honored to be at NASA serving as its Chief Technologist. As the NASA Administrator's top advisor on technology, I am responsible for guiding strategic Agency investments in technology; facilitating technology transfer, partnerships and commercialization activities across the Agency; advocating externally on behalf of NASA's R&D programs; demonstrating and communicating societal impacts of NASA technology investments; as well as, the executive management of the Space Technology Program.

The National Research Council (NRC) recently released its review of NASA's Space Technology Roadmaps, a comprehensive collection of technology strategies and pathways to advance the Nation's current capabilities in space. "Success in executing future NASA space missions will depend on advanced technology developments that should already be underway," wrote the NRC. "It has been years since NASA has had a vigorous, broad-based program in advanced space technology development, and NASA's technology base is largely depleted." The Space Technology Program has been engineered to refocus NASA on solving the toughest technological challenges so our Nation can pursue goals currently beyond our grasp.

As requested in your invitation to appear today, my testimony will address NASA technology transfer and commercialization efforts, which are often referred to as "spinoffs," and how NASA broadly shares its research and development to benefit commercial endeavors and the Nation. My testimony will also discuss a critically important part of this process—how the Office of the Chief Technologist coordinates and prioritizes R&D investment across NASA, and what NASA is doing to address the findings cited in the Inspector General audit of the Agency's technology transfer activities.

NASA Research and Technologies Drive the Growing Space Industry

Since its inception, NASA has been charged by its founding legislation The National Aeronautics and Space Act of 1958 to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." As we seek to achieve our national objectives in human space exploration, aeronautics, and scientific discovery, we create signposts in the form of data and research results that serve as pathfinders for subsequent advancements within the aerospace community. To give a sense of the magnitude of data available, NASA's Technical Reports Server (NTRS), which makes the Agency's technical literature and engineering results available to the public, holds over 500,000 aerospace-related citations, 200,000 full-text online documents, and 500,000 images and videos. Each year over 3.3 million people access NTRS. NTRS content continues to grow as new scientific and technical information is created or funded by NASA. The types of information found in the NTRS include conference papers, journal articles, meeting papers, patents, research reports, images, movies, and technical videos.

Commercial aerospace enterprise and researchers alike have access to and utilize data and analysis on topics such as: aerodynamics, propulsion, aircraft construction, materials, engineering, mathematical and computer sciences and so much more. By sharing NASA's findings and results, and making available NASA expertise to industry, the Agency has enabled airplane manufacturers to find the data they needed to build more fuel efficient aircraft. Satellite manufacturers have learned what materials endure in the harsh environment of space, thanks to reports from the Long Duration Exposure Facility (LDEF) and the Materials International Space Station Experiment (MISSE) test beds. In addition, NASA's workforce provides technical assistance. By providing companies with support from Agency experts, NASA can help solve technical challenges similar to those seen by the Agency. This hands-on support has helped companies like SpaceX quickly determine what type of heat shield was required to return cargo safely from space.

NASA Aeronautics Technology

NASA continues to lay the foundation for the future of flight by exploring new ways to manage air traffic, build more fuel-efficient and environmentally friendly airplanes, and ensure aviation's outstanding safety record. Through the research we conduct and sponsor with universities and industry, we help to develop the technology that enables continuous innovation in aviation.

NASA-developed technologies are in the DNA of many of the civil and military aircraft the U.S. industry has developed and marketed to date. American manufacturers have introduced highly competitive aircraft and engines in the last two years. With the introduction of these new products, our Nation's manufacturers appear to be well positioned in the large commercial transport market for some time to come. However, their success is not assured, and careful attention to aeronautics investment is required to maintain American leadership in this area.

NASA is investing in cutting edge research to accelerate implementation and enhance the capabilities of the Nation's Next Generation Air Transportation System (NextGen) in partnership with the FAA and other Joint Planning and Development Office partners. With our partners, we are investing in critical areas of research such as new air traffic management concepts for new fuel-efficient arrival procedures. And we are leading the country with a vision and revolutionary capabilities for the Nation's future air transportation system, researching concepts and technologies that may provide the foundation for future commercial products and services brought to the market.
We transfer the outcome of fundamental and systems-level aeronautics research to the aerospace community through dissemination of research results, concepts, and design methods. In some instances, companies may build on specific technologies and capabilities developed through NASA research,

investing their own research and development resources to take those last steps toward becoming a commercialized product. In other instances, NASA provides design methods and understanding used by companies in developing new products. By maturing new technologies and validating design methods, NASA research can help decrease the risk of incorporating new technologies and systems in aircraft, shortening the path through safety certification in the Federal Aviation Administration and speeding the transition of new technologies into the fleet.

Sparking Innovation on Earth

While not the Agency's primary objective, NASA provides America with unique capabilities simply because we take on extraordinarily difficult problems in technology and science. By taking humans to inhospitable places, we learn key skills, like keeping people healthy when the nearest hospital is days away. Meeting these challenges translates into benefits like the advanced ultrasound devices created in partnership with NASA, Henry Ford Hospital in Detroit, and the Epiphan company in Springfield, New Jersey. Using this portable ultrasound machine, a non-physician can, with minimal technical know-how, send medical imaging for consultation with experts. This device is now employed by emergency medical personnel around the country, as well as by coaches and sports teams. This example is just one of hundreds that show how solving technical problems in aerospace, we are also inventing technologies that make life better right here on Earth.

NASA's investments also stimulate the growth of the innovation economy. Knowledge provided by weather and navigational spacecraft, efficiency improvements in both ground and air transportation, super computers, solar- and wind-generated energy, the cameras found in many of today's cell phones, improved biomedical applications including advanced medical imaging and even more nutritious infant formula, as well as the protective gear that keeps our military, firefighters and police safe, have all benefitted from our nation's investments in aerospace technology.

We also see benefits of NASA innovation with companies like GreenField Solar, who developed PhotoVolt solar cells through cooperation with NASA's Glenn Research Center in Cleveland, Ohio. When paired with the StarGen solar concentrator, which tracks and captures the sun's rays throughout the day, this system can concentrate sunlight up to 900 times its normal intensity to dramatically boost the efficiency of solar panels. GreenField solar is now generating grid-scale solar power at a lower cost per kilowatt-hour than most existing photovoltaic systems. U.S. job opportunities will increase as GreenField ramps up its commercialization efforts. This is a single example, but one of nearly 2,000 NASA has collected in its annual *Spinoff* publication.

While these stories provide a collective and qualitative answer to the question of the benefits of NASA technology here on Earth, the question still remains as to the true return on investment of NASA's activities. Toward that end, NASA has begun new methods for capturing the impact of secondary use of NASA-funded discoveries. A multiplier showing NASA's return on investment is not the goal. Rather, NASA is working to supplement the traditional reporting in *Spinoff* with quantitative data, and through analysis of this data, providing a better understanding and an ongoing measurable record of the societal benefits resulting from the Agency's investment in innovation. By surveying firms represented by those stories in *Spinoff*, NASA has collected quantitative data retrospectively on the numbers of jobs created; revenue generated; productivity and efficiency improvements; lives saved; and lives improved as a result of NASA technology transfer.

NASA will collect and standardize reporting of these quantitative benefits each year, as the *Spinoff* stories are collected and developed. While only a subset of all the benefits generated by the Nation's investment in space research and technology, this new qualitative framework provides a sustainable and consistent source of data from the top technology transfer successes published in *Spinoff* each year, with the data coming directly from the firms that are commercializing NASA technologies.

To date, the returns have proven impressive. NASA can now say with certainty that technology transfer has helped to create thousands of jobs, generated billions of dollars in revenue, and saved hundreds of thousands of lives. For example, we consider the worldwide search and rescue system founded thanks to NASA innovation. Enabled in part by satellite ground stations developed and constructed by a NASA partner, the true value of this spinoff is incalculable—more than 30,000 lives saved, on average more than 6 a day, from the highly publicized 2010 rescue of teen sailor Abby Sunderland to fishermen, hikers, and adventurers around the world. While this type of data represents an important aspect of NASA's efforts to document its spinoff successes, it still tells only a part of the exciting, complex, and unique stories of the NASA and industry innovators who create these technologies, the partnerships that help deliver them to the public, and the individuals and communities who benefit.

Technology Transfer

NASA's directional shift toward increased technology development has allowed the agency to energize the inventors, engineers and technologists, enlisting their help in bridging the gap from today's NASA to that of tomorrow. New technologies will bring improvements in how we explore, navigate and understand our universe. They will also represent new opportunities for industry and small businesses alike to gain from government funded research and development. Through the work of the NASA Innovative Partnership Office(IPO), the Office of the Chief Technologist (OCT) develops partnerships and manages the transfer of NASA-developed technology to industry, connecting NASA's research and development to those who can apply it to commercial use.

IPO works with all NASA Mission Directorates and Centers to ensure Agency-developed technologies, processes, discoveries, and knowledge are available to the private sector. Technology transfer at NASA is conducted through various means including public-private partnerships with local, state and regional organizations; collaborations and cooperative activities with commercial companies, other Government agencies and academic and research institutions for the purpose of developing technologies to both enable NASA to meet its mission needs and to contribute to the nation's commercial competitiveness; and traditional intellectual property management, such as licensing of patented technologies.

This spring, the NASA Inspector General concluded an audit of NASA's technology transfer activities and noted that:

- NASA personnel lack awareness of the agency's technology transfer policy requirements;
- technological assets are not consistently identified or fully understood;
- innovators lack awareness of new technology reporting process; and,
- new technology reports are inaccessible.

NASA agreed with the findings and is making improvements to its program and process.

The Agency is rewriting its technology transfer policies to better match current best practices as well as address commercialization planning. The new policy will provide a streamlined, broad, flexible approach to core technology transfer activities, with an emphasis on coordination of technology transfer offices with programs and projects. This increased coordination will assist NASA in best understanding the value of identified technological assets. Revised policies will go into effect in 2013, at which time NASA will pursue activities to increase internal awareness of these policies.

To build awareness of the new technology reporting requirements, NASA has launched a series of initiatives to increase new invention capture, including the development of an online training module, a redesign of the online system for invention disclosure, and an active outreach campaign.

Building awareness of the new technology reporting and technology transfer processes will improve the understanding of what happens when a new technology report is submitted. Additionally, the engagement with programs and projects at the early stages of commercialization planning will further help innovators to understand what happens when a new technology report is submitted.

NASA is also considering development of a system, similar to a package delivery tracking system, where innovators would log on to the online submission system to see where in the process the disclosure is.

NASA embraces the challenges of addressing the Inspector General's concerns, as the Agency recognizes the importance of this program, not only to NASA, but also the Nation.

Not only is technology transfer important to NASA, but the President charged all Federal agencies with accelerating technology transfer activities[1] and, thereby, the benefits of Federally-funded research and development investments. NASA is strategically positioned to answer that call, building upon a legacy of leadership in technology and transfer of space and aeronautics research for public benefit. In response to that directive, NASA is in the process of developing a five-year plan to improve its technology transfer program activities. Key objectives in the draft plan include the following:

- fill the technology-transfer pipeline through a renewed, Agency-wide emphasis in technology research and development;
- revise the Agency's policies on commercialization to ensure alignment with NASA's current focus on technology development and best practices in technology transfer;
- build partnerships for technology development, transfer, and mutual benefit;
- tie the technology-transfer process into all stages of technology development, ensuring that formal technology transfer is considered even at the earliest stages, when programs and activities are being formulated and acquisitions planned;
- increase the number of new technologies reported by NASA civil servants and contractors;
- improve licensing processes and outcomes; and,
- consider other tools and authorities for accelerating licensing of technologies.

Each of these objectives is supported by a series of identified activities and metrics, and the NASA field center technology transfer offices are working to develop an implementation plan to move out on these activities in FY 2013.

Additionally, NASA is in the process of supplementing the core Agency technology transfer capabilities by restoring resources for technology assessments, bridge funding, market analysis, and marketing of technologies.

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1 Presidential Memorandum -- Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses http://www.whitehouse.gov/the-press-office/2011/10/28/presidential-memorandum-accelerating-technology-transfer-and-commerciali

NASA has already implemented improvements in communication of its technology transfer efforts through the launch of its new Technology Transfer Portal: http://technology.nasa.gov. The portal is an Internet-based, one-stop shop for the Agency's intellectual property assets. The site features a searchable, categorized database of NASA's patents, a module for reaching out to a NASA technology transfer specialist, and articles about past successful commercialization of NASA technology. Historical and real-time data for NASA's technology transfer program also are available at any time. The public can access interactive graphs showing how many inventions NASA is reporting, how many of those are patented, and how any are licensed to industry for commercial application.

Other initiatives have been identified and are being implemented to help NASA fulfill its technology transfer goal and objectives such as, an automated licensing pilot and a student business plan competition built around NASA intellectual property.

To further demonstrate NASA's commitment to technology transfer, NASA has added technology transfer to the top-level, Agency-wide performance goals reported annually to the Office of Management and Budget (OMB). For FY 2012 to 2013, one of NASA's five Agency Priority Goals (APGs) is a set of key technology transfer metrics. This performance goal emphasizes that NASA is committed to the transfer of NASA technologies to industry, academia and other Government agencies to improve the U.S. economy and the quality of life for all Americans.

Investments in Space Technology Spur Innovation

Each NASA mission takes years of planning and development to ensure its success, and every NASA mission has been made possible by pushing the technology envelope. If NASA and this Nation are to reach the goals set for us by this Congress, we must drive to innovate. The Office of the Chief Technologist (OCT) coordinates the Agency's technology programs, one of which is the Space Technology Program. This program's mission is advancing technologies and concepts that address NASA's needs and contribute to other aerospace and national needs. It is no accident that the same office is the home of both technology development and transfer efforts; the two are naturally synergistic. OCT identifies development needs across the Agency, prioritizes those needs according to stakeholder input, and reduces duplication to ensure that the Agency's resources are used wisely. By coordinating technology programs across NASA, OCT facilitates infusion of available and new technology into systems that ultimately advance specific human-exploration missions, science missions, and aeronautics capabilities. And with the help of the incredible new ideas that are emerging from the Space Technology Program, OCT is helping to ensure a robust technology transfer enterprise for the Agency.

In managing the Space Technology Program, OCT employs a portfolio approach, investing in both crosscutting and human exploration specific technology needs for the Agency. The broadly relevant technologies being pursued within the Program span a range of discipline areas and technology readiness levels (TRL) from concept study to flight demonstration, including technology demonstrations conducted on the International Space Station.

Building partnerships for technology development, transfer, and mutual benefit is a key objective of the Space Technology Program. NASA's partnership programs are robust, maximizing our resources and increasing benefits to the Agency and the Nation as a whole. NASA participates in national technology-development initiatives such as the National Nanotechnology Initiative, the Advanced Manufacturing Partnership and the National Robotics Initiative to increase opportunities for collaborative technology development. In the latter, four agencies (the National Science Foundation, the National Institutes of Health, NASA, and the Department of Agriculture) have issued a joint solicitation that will provide up to $70 million in research funding for next-generation robotics. This partnership focuses on developing robots that work with or beside people to extend or augment human capabilities, taking advantage of the different strengths of humans and robots. In addition to investing in the core technology needed for next-generation robotics, the initiative will support applications such as robots that can: increase the productivity of workers in the manufacturing sector; assist astronauts in complex, hazardous, and challenging missions; help scientists accelerate the discovery of new, life-saving drugs; and improve food safety by rapidly sensing microbial contamination.

Space Technology development takes place using NASA centers, academia and industry, and through collaboration with other Government agencies and international partners. Investments include both competitively awarded and strategically-guided activities to address long-term Agency technology priorities and technology gaps identified within the Agency's space technology roadmaps. Space Technology invests in crosscutting technologies that could benefit human exploration, change the way science missions are conducted and increase efficiency for American industries.

The Space Technology theme also includes the Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR), which encourage small business owners to provide technical innovations. SBIR and STTR continue to support early-stage research and development performed by small businesses through competitively awarded contracts. These programs produce innovations for both Government and commercial applications. SBIR and STTR provide the high-technology small business sector with an opportunity to develop technology for NASA, and commercialize that technology in order to provide goods and services that address other national needs based on the products of NASA innovation. NASA recently selected 260 SBIR Phase I and 85 SBIR Phase II awards, and 40 STTR Phase I and ten STTR Phase II awards.

In all, NASA's Space Technology Program has already funded roughly 1,000 technology projects and engaged thousands of engineers and technologists since its inception in 2011. Several of these projects have hardware ready to test and fly in FY 2013 as they mature their technology for infusion into a future mission or capability. So far in FY 2012, NASA has selected 48 students for Space Technology Research Fellowships. These fellowships allow NASA to engage the next generation of innovators in developing promising technologies supportive of NASA's missions and strategic goals. They join Space Technology's inaugural class of 79 student researchers returning to continue their second year of research. On the International Space Station, we have demonstrated precise maneuvers with the robotic refueling mission, an effort we co-fund with the Human Exploration and Operations directorate at NASA. In addition, we have been remotely controlling robots on the ISS, including Robonaut, NASA's humanoid robot handyman. We have entry, descent and landing sensors riding on board the heat shield of the Mars Curiosity Rover waiting to collect data on the Martian atmosphere during entry. We are excited to see Curiosity reach its final destination on August 6, 2012.

The Nation's first Space-Based Laboratory-Open for Business

The International Space Station (ISS) is fully complete. Many consider it to be one of humanity's greatest technological achievements. Its state-of-the-art research facilities support a wide variety of research disciplines. Examples include high-energy particle physics; Earth remote sensing and geophysics experiments; protein crystallization experiments; human physiology research (including bone and muscle research); radiation research; plant and cultivation experiments; combustion research; fluid research; materials science experiments; and biological investigations. The three major science laboratories aboard the ISS: the U.S. Destiny, European Columbus, and Japanese Kibo facilities, along with external test beds, enable astronauts to conduct experiments in the unique, microgravity and ultra-vacuum environment of LEO, experiments that simply cannot be conducted on Earth. The range of research disciplines that ISS supports means that research and development conducted aboard Station promises new discoveries not only in areas directly related to NASA's exploration efforts, but in fields that have terrestrial applications, as well.

In the NASA Authorization Act of 2010 (P.L. 111-267), Congress directed that the Agency enter into a cooperative agreement with a not-for-profit organization to manage the activities of the ISS National Laboratory. Last fall, NASA finalized an agreement with the Center for the Advancement of Science in Space (CASIS) to manage the portion of the ISS that operates as a U.S. National laboratory. CASIS will be located in the Space Life Sciences Laboratory at the NASA Kennedy Space Center. This independent, nonprofit, research-management organization will help ensure the Station's unique capabilities are available to a broad cross-section of American scientific, technological and industrial communities.

CASIS will develop and manage a varied research and development portfolio based on U.S. national needs for basic and applied research, establish a marketplace to facilitate matching research pathways with qualified funding sources, and stimulate future interest in using this national lab for research and technology demonstrations and as a platform for science, technology, engineering and mathematics education. The goal is to support, promote and accelerate innovations and new discoveries in science, engineering and technology that will improve life on Earth.

In addition to the direct research benefits to be gained by the ISS as a National Laboratory, this innovative arrangement also supports NASA's effort to promote the development of a LEO space economy. National Lab partners can use the unique microgravity environment of space and the advanced research facilities aboard Station to enable investigations that may give them the edge in the global competition to develop valuable, high technology products and services. Furthermore, the demand for access to the ISS will support the providers of commercial crew and cargo systems. Both of these aspects of the ISS as a National Laboratory will help establish and demonstrate the market for research in LEO beyond the requirements of NASA.

Conclusion

America is beginning an exciting new chapter in human space exploration and scientific discovery. Revolutionizing aerospace science and taking informed risks, NASA and our Nation remain at the cutting edge.

Whether we are developing needed technologies for space exploration or advancing the nation's aeronautics capabilities, great ideas from NASA have a way of spreading to the benefit of everyone. It should come as no surprise, then, that the technologies powering NASA missions are used by pioneering individuals to create and improve products and services that benefit life on Earth. Investments in research and development enable new missions, stimulate the economy, contribute to the Nation's global competitiveness and inspire the Nation's next generation of scientists, engineers and explorers.

As a professor at Cornell University, I have had the honor of working with talented faculty and students who share my passion for space. For most of the past decade, very few of us who have wanted to contribute to the Nation's civil space program have had the opportunity to do so. The desire to engage with NASA is overwhelming. We see this in the fact that OCT receives many more proposals to its solicitations than it can afford to fund. And I have seen it personally, in the hundreds of students who have worked with me on two university-built satellite projects. This experience gave them the skills needed to step into the engineering workforce prepared to problem solve and innovate. NASA must continue to cast a wide net to bring in the best ideas, wherever they may be found.

A NASA focused on advancing technology helps ensure that high-tech jobs will be available for these young people when they complete their studies. And in sponsoring research and development, it will do its part to encourage the next generation of aerospace engineers, ensuring that our Nation retains the critical capabilities in advanced technology that will ensure its economic competitiveness.

Our Nation's future economic success is tied to our ability to out-innovate the rest of the world. NASA is an important part of this future. America expects boldness from NASA. We are now returning to our innovation roots, taking the long-term view of technological advancement that is essential for accomplishing our missions. America expects no less.

Mr. Chairman, thank you for your support, and that of this Subcommittee. I would be pleased to respond to any questions you or the other Members of the Subcommittee may have.

Chairman PALAZZO. Thank you, Dr. Peck.

I now recognize our next witness, Mr. George Beck, for five minutes to present his testimony.

**STATEMENT OF MR. GEORGE BECK,
CHIEF CLINICAL AND TECHNOLOGY OFFICER,
IMPACT INSTRUMENTATION, INC.**

Mr. BECK. Thank you, Mr. Chairman. Thank you for the opportunity to speak on behalf of the owners of Impact Instrumentation and the employees. We are a small business in New Jersey, and this is a unique opportunity for all of us.

Our relationship with NASA has not been a traditional spin-off. It has actually been more of a spin-in. Impact Instrumentation has developed and manufactured life-support equipment used by the Department of Defense and other government organizations as well as civilian care providers for the last 35 years.

While I was a member of Wyle Laboratories at the Johnson Space Center, our group modified an Impact ventilator that was currently being used by the military to transport critically ill and injured war fighters back and forth from Iraq and Afghanistan. We developed the device to answer the needs for space and improve its capabilities so that it could work in a bi-directional matter. While the modified ventilator was never used in space, its development helped identify a method whereby NASA and industry could work cooperatively to leverage commercial technology for space.

Working together, we have developed a number of prototypes for advanced life-support devices that replace a suite of therapeutic and monitoring equipment. In addition, Impact has completed development of a new ventilator that is deployed with our forces that has also been tested by NASA with the anticipation that it would replace existing equipment on space station when it is retired.

That said, our biggest leverage has really been the cultivation of a new generation of young engineers and researchers that are working at NASA, at Impact or in academic centers or have left to start their own small businesses. The Space Act Agreement created a government, industry and academic partnership that has allowed our group to work on a series of medical challenges, sharing in the institutional knowledge and experience of the organizations while developing solutions that currently now benefit war fighters, astronauts and civilians, so I look forward to answering any questions that you might have.

[The prepared statement of Mr. Beck follows:]

Congressional Testimony 12 July 2012
George Beck Chief Clinical and Technical Officer
Impact Instrumentation, Inc. West Caldwell, NJ

1. How did your company partner with NASA and what technologies resulted from that partnership? How have you leveraged those technologies into commercial products?

   Response:
   Our relationship with NASA has not been the traditional spin off, it has been more of a spin in. Impact Instrumentation, Inc. has developed and manufactured life support equipment that is used by the Department of Defense (DoD), other governments and civilian care providers for the last 35 years. While I was a member of the Wyle Laboratories Advanced Projects Group at NASA our group modified the Impact ventilator that the military was using to treat and transport critically injured warfighters from the battlefield, through in-theater care and back home to the United States. The testing and certification that the device needed to meet military specification is very similar to the requirements NASA has for equipment used in space. While the modified ventilator was never used in space, its development helped identify a method whereby NASA and industry could work cooperatively to leverage commercial technology for space.

   I joined Impact and we began a series of projects to develop new technology for the military that expanded the level of care for ill or injured patients while at the same time reducing the mass, volume and power of these devices. We received funding from the Defense Advanced Research Projects Agency (DARPA), US Army Medical Material Development Agency (USAMMDA) and the Office of Naval Research (ONR). Recognizing that these solutions would be useful for both military and space applications, we developed a series of noncompensated Space Act Agreements that enabled Impact to share technology that we were developing with NASA. This allowed NASA engineers access to the technology early enough in its development so that they could identify space-specific issues that may require change to the device or its implementation in order to meet operation and safety issues unique to the NASA mission. It also allows NASA to be part of the device's required Food and Drug Administration (FDA) and ISO testing and use these tests as a method to demonstrate the safety and efficacy of the space device.

   Working together we have developed a number of prototypes of an advance life support device that replaces a suite of therapeutic and monitoring equipment. In addition, Impact has completed development of a new ventilator that is deployed with our forces and has also been tested by NASA with the anticipation that it would replace existing equipment on the space station when it is retired.

   That said, the biggest leverage has been the cultivation of a new generation of young engineers that are working at NASA, at Impact or who have left the projects to start their own businesses. The Space Act Agreement (SAA) created a government, industry and academic partnership that allowed our group to work on a series of medical challenges, sharing in the institutional knowledge and experience of the organization while developing solutions that benefit the warfighter, astronauts and civilians.

2. What has been the direct economic benefit of this investment? What are the other benefits to society in general that can be derived from these products?

   Response:
   We have benefited by the addition of NASA and NASA-contracted engineers that have been part of the different programs under the SAA. Their labor has contributed to the development and testing of equipment we have developed for the DoD and civilian use. In addition, as a small business, we have benefited from the association with NASA. Though we have never marketed our products with any association with NASA it is known in the military that we work with NASA and that has positively affected the standing our company, products and development efforts.

   Societal benefits are difficult to determine but as a group we have authored a number of peer-reviewed papers on telemedicine, care of critically ill or injured patients in remote environments and closed-loop control of mechanical ventilation and other therapeutic modalities whereby the devices will be able to manage themselves in the absence of a skilled care provider. Devices that have been commercialized are smaller, lighter and more capable than commercial devices that, 15 years ago, weighed ten times more than the equipment our military is now using. These breakthroughs are benefiting our military and will benefit NASA as the next generation of space missions get underway. Civilians around the world have benefited as technology that we've shared with NASA has been used to treat earthquake victims in Haiti and is stockpiled for use by a number of nations around the world as part of their disaster preparedness programs.

3. How might future partnerships with NASA enable continued technology developments?

   Response:

   Just as NASA is partnering with commercial aerospace companies to develop its next generation space vehicles, it should also partner with other industries to develop capabilities that are needed in for both space and terrestrial applications. Doing this:

   1. Leverages the resources of both organizations. NASA benefits through direct access to emerging technology while the company benefits through access to a talented population of engineers and researchers as well as use of the finest collection of test and evaluation laboratories in in the world.
   2. Timelines at NASA are improved based on the drive that companies have to commercialize technology.
   3. Companies benefit from the health and safety culture that is inherent in sending people into space and returning them safely.

While there certainly can be culture clashes between the NASA and a commercial organization, a program that promotes collaboration and partnership leverages the best of both, spurs development and deployment of technology, promotes domestic job growth and incubates a new group of American engineers and researchers.

4. What were the greatest challenges working with NASA and what improvement, if any, do you recommend that would enhance NASA's ability to more quickly transition their ideas into new products?

Response:

Our greatest challenge was overcoming the questions as to why would we want to have a noncompensated space act agreement. Fortunately, there were people in the Advance Projects Group and managers in the NASA Space Medicine Branch office that recognized that working together would benefit both groups. NASA would benefit by recognizing that much of the technology that's needed for its next missions is available commercially and that by working with industry costs can be reduced and timelines accelerated. The benefits to industry, whether uncompensated or compensated can be significant as our government support development, testing and multiuse deployment of new technology.

Chairman PALAZZO. Thank you, Mr. Beck.

I now recognize our next witness, Mr. Brian Russell, for five minutes to present his testimony.

STATEMENT OF MR. BRIAN RUSSELL, CHIEF EXECUTIVE OFFICER, ZEPHYR TECHNOLOGY

Mr. RUSSELL. Chairman and Members of the Committee, it is an honor to appear today before you to represent our friends and partners at NASA. Zephyr is a global leader in the art and science of remote physiological monitoring, or PSM. That is how we became partners with NASA.

The story of that partnership illustrates the profound benefits of NASA funding. That funding spurs and accelerates research, technology and innovation that in partnership we are helping to save lives and make people fitter and healthier.

Zephyr first became involved with NASA in 2008 where William Toscano and Patricia Cowlings' work at the Ames Research Facility, they studied people with motion sickness due to zero gravity, fighter pilots and fatigue in airline pilots. They used our BioHarness, which is our comfortable physiological monitoring sensor, to measure people's vital signs including fatigue, EKG and other parameters. We are also working with NASA on PHASER, which is a DHS program to save first responders lives.

Through these studies, Zephyr not only serves the interests of NASA, DHS and DOD, they in turn served our needs. We receive critical feedback based on decades on their experience that helped us incorporate their experience into our design decisions. Those products are now making major contributions in several very important areas: sports and fitness, Special Forces and first responders for both training and operations, and perhaps most importantly today, mobile health.

Through TSWG we have partnered with Special Forces in the Army and the Navy to create a system to not only train but to monitor a person's safety and health during field missions. Field commanders and medics can make more informed time-critical decisions based on if someone is stationery, moving, dehydrated, had heat stressed or is actually suffering trauma from an injury. So we proving mission readiness, safety and training and extending their abilities in dynamic asymmetric warfare.

Zephyr's PSM solutions are currently being used in the Olympics next month, Major League Baseball, NBA, collegiate sports, and even on Formula One racecar drivers. A coach can measure and train an athlete to peak performance while preserving his health and keeping—sorry—enhancing the athlete's health.

A terrific dual use of our technology is to help professionals, hospitals, nursing homes, families and even individuals. Zephyr's web and smartphone system called ZephyrLIFE allows nurses to monitor real-time parameters in a hospital and doctors remotely can measure them anywhere in the world.

This technology is selling now. The availability in large part is due to the researchers at NASA. Working with NASA gave us the information and feedback we needed to move from the realm of science fiction into the mainstream, and Zephyr is giving back. NASA was deeply involved with the rescue of the 33 Chilean miners that were trapped 2,000 feet below the ground last year. Because of our experience with NASA, Zephyr was called on for help. We provided BioHarnesses, monitoring software and field support. Doctors were able to monitor the miners' wellness for the weeks underground to keep them fit and healthy for their rescue while monitoring them during the extraction and give them needed immediate medical support once they reached the surface. And now Zephyr is sharing all of that data collected during those dramatic weeks with NASA. It is the only event in recorded human history that mimics the conditions of long-endurance space travel where the nearest doctor may be a very, very long way away.

This brings me to my concluding point. The scientists and legal department at NASA understood us. They gave us a simple process and brought us in as partners. As a result, Zephyr has improved and advanced its products, which are truly dual use—helping doctors, patients, athletes, soldiers, firemen and all of us and our families who want to stay fit and healthy including NASA and its astronauts. The success has let us grow and employ more people. Some of those advancements from working with NASA we could have predicted but some we couldn't have imagined when we started.

So please allow me to finish where I started. Because of this, the really basic truth of the testimony is the funding that NASA has and the way it has helped us has truly made a difference. Thank you.

Do we have a video to show now or at the end? Okay. So the video I would like to show now is the latest release of a sports product that is—this is a sports application. We have just delivered this to Fort Bragg.

[Video playback]

[The prepared statement of Mr. Russell follows:]

Zephyr
technology

Brian Russell
Founder & CEO, Zephyr Technology

Testimony before the Space and Aeronautics Subcommittee
Committee on Science, Space and Technology

July 12, 2012

Chairman Palazzo, Ranking Member Costello and members of the subcommittee:

It is an honor to appear before you today to testify on behalf of our friends and partners at NASA.

My name is Brian Russell, and I am CEO and founder of Zephyr Technology. I came to the U.S. as an entrepreneur. Zephyr Technology was born nine years ago. Today we are an American company, headquartered in nearby Annapolis, Maryland. We have investors such as Motorola and 3M and investors that understand government business. We employ 35 people. Zephyr is a global leader in the art and science of remote Physiological Status Monitoring, or PSM. That's how we became partners with NASA.

The story of that partnership illustrates the profound benefits of NASA funding. That funding spurs and accelerates research and technological innovation that not only furthers our space program, but saves lives, improves health, bolsters military and emergency readiness, gives birth to a wide range of beneficial consumer products and, in doing all of that, allows small companies like mine to be competitive, to maintain and create jobs in this country and to contribute to the economy. It is hardly an overstatement to say that nothing but good – a great deal of good – comes from funding NASA programs.

Zephyr first became involved with NASA in 2008, as part of William Toscano's and Patricia Cowlings's work at the Ames Research Center, Physiological Laboratory. They study areas including: motion sickness due to zero-gravity and fatigue in airline pilots and first responders. Under a Space Act Agreement, NASA partnered with Zephyr to remotely measure and interpret physiology. They used our comfortable, lightweight BioHarness™ to collect live physiological data. They also used our products for the Department of Homeland Security's Physiological Health Assessment System for Emergency Responders, or PHASER, transmitting live data over Motorola radios. I am proud to be an advisory board member for the PHASER program, which is working to reduce deaths of first responders.

Through these studies, Zephyr not only served the interests of NASA, DHS and DOD – they, in turn, served our needs. We received critical feedback based on decades of experience on design decisions to incorporate into our new products. Those

Zephyr
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products are now making major contributions in several important areas – sports and fitness, Special Forces & First Responder training-and-operations and, perhaps most importantly, mobile health.

Through TSWG we have partnered with U.S. Special Forces in the Army and Navy to create a system not only to train, but to monitor a person's safety and health during field missions. Field commanders and medics can make fully informed, time-critical decisions based on whether someone is stationary, moving, dehydrated, is suffering heat stress or is injured. So we are improving their mission readiness, safety in training and extending their abilities in dynamic asymmetric warfare.

Zephyr's PSM solutions are currently being used in major league baseball, the NBA, European soccer, collegiate sports, Formula 1, professional tennis and more. A coach can measure and train each athlete to peak performance while preserving and enhancing the athlete's health.

A terrific dual use of this technology is for our products to help medical professionals, hospitals, nursing homes, families and even individuals. With Zephyr's web and smart phone system called ZephyrLIFE, a nurse can monitor, in real time, the condition of every patient in a ward, seeing everything from EKG to detecting a fall. Doctors can monitor their patients remotely – even if the patient is visiting family in Hawaii while the doctor is in his office in Atlanta. And a personal passion of mine is wellness, where this technology has taken big data and simplified it into a single Health Number from 0 to 10. This type of application will save the country by keeping people healthier and then reducing costs if they become sick.

This technology is selling NOW. The availability in large part is due to the researchers at NASA . Working with NASA gave us the information and feedback we needed to move from the realm of science fiction to the mainstream.

And Zephyr is giving back. NASA was deeply involved in the rescue of the 33 Chilean miners who were trapped 2,000 feet below ground last year. Because of our experience with NASA, Zephyr was called on for help. We provided BioHarnesses, monitoring software and in-field support personnel. Doctors were able to monitor the miners' wellness for the weeks they were trapped, keeping them healthy through training regimes and monitoring. During the extraction in the rescue capsule, doctors were able to monitor the miners' vital signs – to provide immediate medical attention on the surface. This is the model for new healthcare where data provides the ability to keep people well and respond quickly when needed.

And now, Zephyr is sharing all of the data collected during those dramatic weeks with NASA. It is the only event in recorded human history that mimics the conditions of long endurance space travel, where the nearest doctor may be a long way away.

Zephyr
technology

This brings me to my concluding point. The scientists and legal department at NASA understood us, kept the process simple and brought us in as partners. As a result, Zephyr has improved and advanced its products which are truly dual use. Helping doctors, patients, athletes, soldiers, firemen and all of us and our families who want to stay fit and healthy – including NASA, and its astronauts. This success has let us grow and employ more people. Some of those advancements from working with NASA we could have predicted. But others, no one could possibly have imagined. Our NASA partnership continues to be a straightforward and mutually beneficial relationship.

Please allow me to finish where I started – because this is really the basic truth of my testimony today: Nothing but good – and great deal of good – can come from funding NASA and its programs.

Thank you.

Chairman PALAZZO. Thank you, Mr. Russell.

I now recognize our next witness, Mr. John Vilja, for five minutes to present his testimony.

STATEMENT OF MR. JOHN VILJA, VICE PRESIDENT FOR STRATEGY, INNOVATION AND GROWTH, PRATT & WHITNEY ROCKETDYNE

Mr. VILJA. Chairman Palazzo and distinguished Committee Members, thanks for taking the time to have some talks on this very important subject to our Nation.

There has been a lot of debate on what the value of NASA is to outside of the space world, and of course, everyone mentions the Teflons, Tangs, memory foam mattresses, but rocket engines are a little more obscure—and you might be wondering exactly what does that have to do with anything else but going into space. Well, to do that, you really have to understand what is so special about these machines, and they are what we call high-energy-density machines, or simply put, they create a lot of energy in a relatively small space, and it creates new engineering and multidisciplinary skills which are very hard to duplicate anywhere else but they have applications across the board. Pratt & Whitney Rocketdyne has been launching satellites, astronauts since the beginning of the space program and we are currently launching most of the DOD satellites today and we have a long heritage in harnessing this really specialty engineering.

A good example of what one of these machines, this is the space shuttle main engine, the RS–25. This is a machine that it takes liquid hydrogen, which is the second coldest liquid in existence, combines it with oxygen, and it produces at about 6,000 degrees Fahrenheit and throws it out at about mach 3, all in the space of about a moderate commercial jet engine yet it produces a thrust of 10 747 jumbo-jet engines. And just pumping the hydrogen has to produce 70,000 horsepower, and the hydrogen is then used to cool the chamber and the nozzle which is directing that steam which is operating well past the boiling point of steel. It would evaporate in seconds if we didn't do this.

So the amount of different technologies that goes into doing this is staggering. It has to control itself 50 times every second just so it keeps at the right thrust level and uses the propellants in the right combination as it ascends into orbit.

In developing the space shuttle main engine, what really drove advances in material science, combustion modeling, high-speed turbo machinery, thermal management, structural assessment, safety engineering, advanced manufacturer and rapid health management. By investing in pushing the state-of-the-art, it really created a source of intellectual capital that is unparalleled anywhere in the world. As the engine development continued, so did the learning. We were able to try new processes. We were able to test them out on real machines, and we learned a lot while we were doing it.

These multidisciplinary advances gained from this investment enabled us to develop the first commercially developed large rocket engine, the RS–68, which today powers the Delta IV launch vehicle. Just recently, the Delta IV launched a national-security payload on June 29th. It is the largest hydrogen engine and we did it commercially because there was going to be a large demand in how many launches we needed. Well, that demand never materialized. In fact, the launch market has been flat for the last several decades, and with new international entrants coming into the market, it has become a very difficult place. So a company like us who is a commercial company really requires something to expand our business so spin-offs are the only place we can go realistically.

Now, we have a long history of doing this. In the past we have commercialized a water-pumping technology, which is based on how we pump propellants in a rocket engine. We have spun that off. Jet skis are a result of that. And so there is that kind of thing. We have also done selective laser centering, making plastic parts, 3D parts printing. We helped pioneer that in the mid-1990s in order to make complex rocket engine parts, but since then we have spun off the business to service the rest of industry and so that technology is a direct outgrowth. There is other examples such as chemical lasers, hydrogen recombiners and flue gas cleaning devices, and those are all basically byproducts of this multidisciplinary skill.

Today we are taking this expertise and focusing it largely on energy. The energy market is huge and growing. The world has a constant need for energy and we need to get it cheaper and cleaner, and so by applying rocket-engine technology, we find that there are many opportunities in this area.

One of the key areas is in solar electric power plants. We are building a solar electric power plant outside of the desert in Nevada that stores electricity and then can dispatch the solar electricity at night so we can produce electricity throughout the evening. That is a world's first. The ability to capture the heat of a thousand suns in a collector is directly derived from our cooling technology experience. We are also working on a gasification device. It is a compact, high-pressure, high-temperature gasification device that can take coal, petcoke and biomass and convert it into syngas. This syngas is used in chemicals. It can be used to make fuel. It can be used to make various other products. Our gassifier operates at higher pressures and temperatures so we get a 90 percent reduction in pressures and temperatures, 20 percent reduction in plant capital cost, and a 15 to 20 percent reduction in end product cost, all this while giving a 30 percent reduction in water usage and a ten percent reduction in CO_2 emissions.

Other technologies that are going along, we are working on a hydrogen generator, a down-hole steam generator so we can go after heavy oil production from deep and cold locations, acoustic generators to improve hydraulic fracturing, and a number of other areas including very efficient power plants which can increase the efficiency of electricity generation by 30 percent. We are partnering with many folks including the DOE and major oil companies in doing this.

It is real important that we have an energy policy or a NASA science policy that continues to make the technology that allows us to go forward and create spin-offs, and that means we have to keep investing in development as well as production as well as coming to new technologies. Having production allows you to measure the quantified measurement of the technologies and what they can mean for you. The development allows you to take these very difficult things and bring them to a point where spin-offs are even possible.

And finally, the advanced technology has to be there so you can really push the bounds. There is no commercial case for investigating these commercial bounds because the payback is so uncertain. So the NASA technology is really that seed corn that allows you later to go on and do that, and that is really where the NASA policy has to be strong and they have to really focus. So we would like to ask that NASA continue to have this whole portfolio of things.

Thank you very much, and I would be happy to answer questions.

[The prepared statement of Mr. Vilja follows:]

Testimony of

John Vilja

Vice-President for Strategy, Innovation & Growth
Pratt & Whitney Rocketdyne
Canoga Park, California

at a Hearing on

Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Committee on Science, Space and Technology
Subcommittee on Space and Aeronautics
United States House of Representatives

12 July 2012

Chairman Palazzo and distinguished members of the Committee:

Thank you for the opportunity to address an issue that is of critical importance to our nation, the need for continued investment by the nation in advanced space technology and the commercial benefits it can provide to adjacent markets.

There has been an ongoing debate regarding the value of space-derived spinoff technologies and capabilities derived from NASA investment. When asked to identify products directly created by NASA, most Americans would name Velcro, Tang, and memory foam mattresses. There are also a significant number of well documented commercial spin-offs in many different areas including medical, transportation and communication which are derived from NASA investment. But what about the potential for commercial spin-offs derived from NASA's advanced liquid rocket engines like the ones produced by our company? This question is best answered by first understanding what is so special about these engines. They represent a special class of engineering described as high energy density products, or simply put, machines that generate an enormous amount of energy in a relatively small space.

Pratt & Whitney Rocketdyne has powered U.S. astronauts into orbit since the beginning of the U.S. human spaceflight program more than half a century ago, on the Mercury and Apollo programs as well as the 30-year long Space Shuttle program. In addition to powering hundreds of people into orbit, Pratt & Whitney Rocketdyne continues to power most DoD space launches, placing security, communication, navigation and weather satellites into orbit that are critical to the safety and security of our nation and our allies. Leveraging our understanding of how technology operates under the most extreme conditions, we are translating our core rocket propulsion knowledge into game-changing, innovative solutions to tackle some of our world's toughest energy challenges.

The main engines on the space shuttle are a great example of a high energy density product. They take liquid hydrogen, the second coldest liquid in existence, and combine it with liquid oxygen, and convert them into steam at temperatures of 6000 degrees Fahrenheit while being expelled at velocities more than three times the speed of sound, all in the space of a moderately sized commercial jet engine. The space shuttle main engine produces the thrust of more than ten 747 jetliner engines. In doing so it has to produce the 70,000 horsepower required just to pump the hydrogen to more than 6000 pounds per square inch, which then cools the combustion chamber and nozzle to protect them from the exhaust steam which is far beyond the boiling point of steel. To control this powerful reaction, the engine adjusts itself fifty times every second to assure it produces the optimal amount of thrust, and consumes the right amount of each propellant as the vehicle ascends into orbit.

The development of this amazing machine that would flawlessly power every single space shuttle mission required significant advances in the areas of material science, combustion modeling, high speed turbo-machinery, thermal management, structural assessment, safety engineering, advanced manufacturing, and rapid health management. By investing in and pushing the state-of-the-art in the initial development of the space shuttle main engine, the nation created a level of intellectual capital in each of these key technical competencies that is unmatched in the world. As the engine continued development and refinement over its decades of service, these skills were further honed, and even more modern techniques were developed and anchored against actual measured operating data. As the continuous development progressed, so did the learning.

The multi-disciplinary advances gained from this investment enabled the development of the nation's first large commercial rocket engine, the RS-68, which is currently powering the Delta IV family of launch vehicles, and most recently propelled a critical national security satellite into orbit on June 29th. We developed the RS-68, the world's largest hydrogen engine entirely on our own funds.

The RS-68 project was originally started in response to projections of significant growth in space launch demand. This demand never materialized. In addition, flat launch demand forecasts and the continual entry of new international and domestic launchers to serve this flat market make growth in this market very challenging.

It has therefore become increasingly important as a commercial space launch provider to branch our business out into adjacent markets in order to remain viable and healthy as a business. In the past, Rocketdyne has successfully commercialized products such as the water jet propulsion systems used in jet skis which were derived directly from rocket engine experience. The use of polymer selective laser sintering was pioneered to make complex molds for rocket engine parts and then subsequently spun off into a stand-alone business servicing the industry at large. There are numerous other examples such as chemical lasers, hydrogen recombiners, and flue gas cleaning devices.

Today, Rocketdyne is very focused on taking our rocket propulsion expertise in materials, temperatures, speeds and pressures under extreme conditions, and leveraging this knowledge into the energy arena. This is a rapidly growing commercial market that will significantly benefit from the introduction of space-derived advanced technologies to increase efficiency as well as reduce production costs.

We are working on the world's first commercial concentrated solar power plant with energy storage and dispatching capability allowing electricity generation even in the evening. It's being built in the Nevada desert using Rocketdyne's thermal management expertise to design the high temperature receiver and mirror tracking software. The ability to handle the concentrated heat of a thousand suns is directly derived from our rocket engine expertise. We are bringing this to market through an alliance with SolarReserve, a company that specializes in commercializing solar power plants.

Also through the application of our rocket engine experience, we are developing a high pressure, high temperature compact gasifier which can more cleanly and efficiently convert coal, petcoke, or biomass into syngas, a product that can be used to produce multiple fuels, chemicals and electricity. Through the application of our design capabilities we are able to provide a 90% reduction in gasifier volume which results in a 20% reduction in plant capital cost while yielding a 15% to 20% reduction in end-product cost. All this, while reducing water usage by 30% and CO2 emissions by 10% over existing gasifiers. When you look at the global demand for coal gasification, particularly in developing countries, these are game changing numbers. This technology has undergone successful pilot plant testing in Des Plaines, Illinois at the Gas Techology Institute and is currently testing a revolutionary dry solids pump at the Energy & Environmental Research Center in Grand Forks, North Dakota. We are partnered with the U.S. Department of Energy, ExxonMobil Research and Engineering, and Alberta Innovates to develop this product for market.

Other, less mature energy technologies currently in work at Rocketdyne include a one-step hydrogen generator capable of bringing similar savings to that market as our gasifier project, a down-hole steam generator capable of heavy oil production from deep, off-shore or extremely cold environment reservoirs, flame assisted water treatment for oil recovery in tar sands, an acoustic generator capable of enhancing hydraulic fracturing used in shale gas production, and an advanced combustion boiler and high-efficiency turbine capable of increasing electric power plant efficiency by 30% while enabling affordable carbon sequestration. Additionally, we have started working in concert with the oil industry to apply rocket launch derived safety analysis and practices to greatly reduce the potential safety and environmental risk from exploration and production in deep and off-shore oil platforms.

In addition to the positive benefit to our business in diversifying our commercial portfolio outside of the space market, this diversification also allows us to better serve our launch engine customers by spreading our fixed operating costs over a larger market base, thus reducing costs for all of our customers, most notably the United States Government.

Each of these technologies have benefited from the learning and development experience gained from our work with NASA. There is no commercial analog to push such investment since the term of any payback is not clearly understood at the start of the projects. The benefit comes from challenging and pushing what we think are our limits and finding ways to push those limits even higher and further. By taking on difficult science and exploration missions in space, we force ourselves into multi-disciplinary advancement, which in turn enables new solutions to some of our toughest challenges here on earth.

The challenge going forward is to keep NASA focused on their charter of tackling new, big challenges. Only through the introduction of new barriers to overcome can we be assured of creating those new breakthrough technologies. Current budgetary pressure on NASA creates an environment where we limit our future missions to those achievable through application of existing technology. While this can be a cost effective approach to reducing development cost, it also deprives the nation of many of the capability growth benefits seen from past investment.

The key to best value in our space expenditure is to create challenging goals that use solutions to past problems as much as possible while simultaneously working challenges where the solution requires technological advancement. A good example of this is in the current push for beyond earth orbit human exploration. The launcher harvests past developments to create an affordable, near-term heavy launch capability capable of a number of never performed space missions. The in-space portions require significant advances in planetary landing craft, human radiation shielding, energy conversion, high efficiency propulsion, and long-term environmental control and life support systems, just to name a few challenges. There are no off-the-shelf answers to these problems. By solving them, the nation will gain valuable intellectual property which will be applied to many yet to be recognized areas.

In my invitation letter to speak to this committee, it was asked what issues we in industry see in working with NASA, and what recommendations we have to enhance the rapid transition of ideas to new commercial products. We would recommend the creation of a unified national space policy able to withstand political changes of wind. It must be a policy that recognizes the need for stable production combined with concurrent development of both new products as well as advanced technologies. These tiers are essential for robust technology transfer. Continuous improvement in a stable production environment identifies the quantified value of advanced technology. New product development forces the application of advanced technologies into practice, enabling them to be applied to adjacent products in non-space sectors. Advanced technology development explores and then pushes the boundaries of what is possible, spending the time and energy to explore areas that could never be examined in the commercial world because of the unquantified return on investment required in any commercial business .NASA's partnership with industry in each of these three areas enables us to leverage of our nation's precious investment in space technology in ways that have tremendous benefit to our nation and our planet. It is critical that we avoid the unnecessary reinventing of capabilities that have already existed for decades, sandbox studies that don't have an industry partner, and "make work" projects for NASA staff that is not otherwise gainfully employed in meaningful work that speaks to NASAs true charter. There needs to be a balance to assure the maximum benefit from our nation's investment in technology.

What I have addressed here is only the technology derived from the development of liquid rocket engines. While some may wonder if an investment in rocket science has bearing on our daily lives, our work provides concrete evidence of world-leading, game changing capabilities that can directly affect the quality of life for everyone on the planet through our rocket engines and the commercial spin-offs resulting from the Government's investment in space technology. We plan to keep them coming. We ask that NASA continues to have the opportunity to keep challenging our nation's current capability and continue going beyond what we believe is possible today.

Thank you again for the opportunity to address the committee today. I look forward to responding to any questions you may have.

Chairman PALAZZO. Thank you, Mr. Vilja.

I now recognize our final witness, Dr. Richard Aubrecht, for five minutes to present his testimony.

STATEMENT OF DR. RICHARD AUBRECHT, VICE PRESIDENT, MOOG INC.

Dr. AUBRECHT. Thank you very much for this invitation to testify this morning.

Background on Moog. We are a company that started in western New York about 50 years ago. It was actually a spin-off of Cornell University at the time. And our core technology we describe as precision motion control. We control flight controls on all sorts of commercial and military aircraft. The same sort of technology is applied on wind turbines, all sorts of power generating. We have been a partner with my pal here from Rocketdyne for about 40 years. We do the steering.

So we started working on NASA programs in the Mercury program in the 1950s and continued evolving our technology as NASA's needs evolved, eventually developing very complicated—they are four-channel redundant flight controls that were applied on the space shuttle. These are for not only steering the rocket engines as it is launched but also the flight control surfaces as the shuttle was landing. That formed a core technology for us in doing our redundant flight controls.

So what is different about that? If you look at the NASA missions, some missions at NASA I would call are hard missions. Putting something into space to begin with was a hard mission. What is really hard is doing a manned space program. So why is that? To begin with, you have obviously people involved with all that. What that means is, is that the probability of failure has to be orders of magnitude less than you are willing to stand for when you are just trying to launch a satellite. So that is a really, really hard problem. And the other aspect of that is, it becomes very public. There is lots of press coverage on that. Other satellites are launched and you read in the paper two days later a $100 million satellite failed to reach orbit. People said oh, so what. If you have that happen with a manned space program, it is all over the front page that evening. So it is a really hard problem, and I think that NASA should focus its efforts in the future on really hard problems, and I will show you why.

Having developed that sort of technology to begin with entails not only developing the hardware but you also have to develop a whole series of other processes and technologies to support doing that. The systems design analysis and integration capability, the design tools, new materials have to be qualified and learn how to fabricate them. All kinds of new fabricating and measuring techniques have to be developed and finally you end up with a design. The key part about that is that there is a design team that works on all of that so it is not just a single person or just a couple of people that are doing this creative sort of work. There is a whole team that enables doing all of that, and that is what I think is really important for NASA to realize, is that the technology that you are developing is not just in the drawings and the reports and the hardware that is built.

What is really important is, you are building a capability of a team of people who understand how to take on a really, really hard problem and as a result of doing that, they develop the confidence to be able to take on other really hard problems. So you build this culture of innovation in a company that is able to do really hard things, and that is what we have done with this. So today we have all the flight controls on the F–35 aircraft. We have all the flight controls on the new 787 at Boeing. We also won the contract at Airbus on the A–350. This is the first time Airbus has ever gone outside Europe for that scale of a subsystem within the aircraft.

So East Aurora, New York, has become the global center for redundant flight controls but then we have also taken the same sort of technologies and applied it to all sorts of other applications for other kinds of launch vehicles, military aircraft, commercial aircraft, business jets, and we also take it and apply it in industrial markets—wind turbines, undersea applications of all kinds. So it is that core technology that we developed starting with NASA in the 1950s that has enabled us to move into all these other fields.

So a couple of key messages with this. It seems to me that NASA is really at a key turning point here. What has happened over the last 40 years is that the technology for launching things into space has become ubiquitous. You see people like Iran and North Korea are able to launch satellites. That is not hard anymore. There is a lot of people able to do that. What is really hard still is manned space, and that will continue to be a very hard problem, and that is where NASA ought to focus its efforts. Deep-space programs the same way. The technology to do the deep-space probes and also do the Mars Rovers and that kind of thing, it is again a really hard problem, and those are the sorts of things that NASA can really provide the funding to advance the technologies to enable us to repeat what we did starting with the NASA projects in the 1950s.

We are working on a couple of new projects right now that I think are indicative of that sort of thing that NASA could really help with. We are developing what are called green propellants. Hydrazine that is used for a lot of applications in space is a really nasty fluid, and we have been working actually with Swedish space in developing green technologies that you can actually take it, it is like alcohol. You can spill it on your hands and it won't hurt you at all. And the other is things like small satellites. Professor Peck can speak on that a lot more than I can. But that is going to enable a lot broader usage of space than previously and NASA is in a position to be able to advance the technologies for doing small satellites that commercial people are just never going to do, and to me, that is the kind of leadership position that NASA ought to be taking and sponsoring these projects and the technologies that can become applicable across a wide range of applications.

I don't think Moog is unique in that. You know, you have heard of some of the other people here. We see the people on either side of the systems we have on the NASA programs and have seen what some of our other people have done. But the other thing we have seen, we are pursuing the new launch vehicles on Constellation and Orion and the derivatives of those programs. We won about three times what we thought we were going to win five years ago on that. So why is that? It is because a lot of the people who used to build that hardware have dropped out and are no longer competing. The reason is, they lost their technology teams. They just simply didn't have the capability internally. It wasn't the will. They just didn't have the assets internally to be able to do the work.

So one of the things that NASA really needs to think about, and I think it is a real challenge for this Committee to think about, is to set program goals, very specific goals, very specific timetables, very challenging technology targets, and then stay with them and fund them consistently. If you don't fund them consistently, the design teams don't stay together and you lose the fundamental capability. If there is one message you can take from me today, that is the thing you guys ought to really focus on.

So thank you very much.

[The prepared statement of Mr. Aubrecht follows:]

MOOG

12 July 2012
Richard Aubrecht, Ph.D.

"Spurring Economic Growth and Competitiveness Through NASA Derived Technologies"

Thank you for the opportunity to testify at the Subcommittee on Space and Aeronautics hearing on the topic of Spurring Economic Growth and Competitiveness Through NASA Derived Technology.

I have worked at Moog Inc., headquartered in East Aurora, NY, for most of my 40 year career. For the past 17 years I have concentrated on the development of Moog's business and technology strategies. In our planning processes I have seen directly the technical capabilities developed on NASA projects be applied to many other products and applications.

Moog has a 40+ year relationship with NASA, beginning with the components supplied for the Mercury Program. On Gemini, Apollo and the Shuttle Programs we developed even more complex actuation systems to steer the engines on the launch vehicles and the Shuttle's flight control surfaces.

As we have seen over the last 20 years, many countries have the ability to design, build and fly rockets. So what is extraordinary about the NASA programs? The manned space programs all have really hard problem statements. It is one thing to launch a small satellite in low-earth orbit. It is quite another thing to put three astronauts on the top of a Saturn vehicle and send them on a mission to land on the moon and return safely. So what makes manned space missions a really hard problem? First, the acceptable probabilities for failure are much, much smaller than unmanned missions. Second, the launches are fully covered by the television news, so the public is very engaged and aware of the successes, and the failures. Because manned space vehicles are really hard problems, there are a couple of consequences. First, the boundaries of technology will be expanded so as to provide more reliable lower weight and higher performance systems. Second, companies will put their best, brightest, and experienced engineers and technologies on the NASA programs.

The result is the development of many new technical capabilities. At Moog, these include:

- Systems design
- Simulation and modeling
- Design tools
- New materials
- New fabrication techniques
- New product designs

Equally important is the confidence developed by the design team that they can undertake the really hard problems, develop new technical capabilities, and succeed.

At Moog, our NASA experiences in the 1960's, 1970's and 1980's enabled us to develop the core technologies for fly-by-wire flight control systems. Since the 1980's we have continued to evolve these flight control technologies in both commercial and military aircraft as well as for all type of space launch vehicles. Today, a Moog led team has all the flight control actuation on the F-35 and Moog alone has all the flight control actuation on Boeing's 787 and the Airbus A350. In addition, we supply the engine steering controls on many of the launch vehicles for commercial and military satellites. The global center for aerospace flight controls is now centered in East Aurora, New York with supporting facilities in Salt Lake City and the Los Angeles area. If we had not participated on the NASA project, we would not have had the technologies, tools and confidence to undertake these many other projects.

It is important for the Subcommittee to recognize that the technical know-how is embodied in the people on the technical teams. There are technical reports, test results, drawings and process descriptions to document the NASA work. However, it is the people, their knowledge and experience which enable the technologies to be applied in other project, other aircraft as well as non-aerospace applications.

I do not believe Moog's experience is unique. I can see the effect on the providers of vehicle elements adjacent to the Moog hardware. Their NASA experiences also caused them to expand their boundaries. Although I do not have a studied knowledge of the hundreds of other systems on the NASA vehicles, my anecdotal data supports the same conclusion. NASA's really hard manned space problem statements push the technology boundaries and has enabled the USA to be the world's leading country for aerospace vehicles, products and technologies.

Why do countries such as China, India and Japan have manned space programs? My observation is that they understand the effect manned space programs can have on the technical competencies in country. They have seen the NASA model and the effect is has had on US industry. They are looking to accelerate the development of hundreds of technologies in country.

At present, NASA is benefiting from Moog's experiences on the F-35, the Boeing 787, the Airbus A350, and many other programs, as all these have enabled us to maintain and innovate our technical competencies. NASA has funded some study contracts since the Shuttle was designed and built, but these are not enough to keep a design and development team together to maintain the technologies necessary for manned space vehicles.

MOOG

12 July 2012
Richard Aubrecht, Ph.D.

"Spurring Economic Growth and Competitiveness Through NASA Derived Technologies"

The invitation letter posed four questions. The above is a long answer to question 1. The following are brief answers to the four questions:

1. "How has your company's NASA work translated into benefits to your company, to the broader economy, and to society? Please provide examples."

   The short answer is that our NASA work enabled is to become the world's leading aerospace flight control company. This has led to more business at Boeing, more efficient passenger aircraft, better flight controls on military aircraft, and more reliable, less expensive launch vehicles.

2. "What challenges does your company encounter in transitioning its NASA work into other business opportunities? What could be done to address those challenges?"

   We have not had any significant challenges in transitioning our technology developed in NASA work to other applications.

3. "How effective are NASA's technology transfer and commercialization efforts, including licensing, and what can be done to enhance them?"

   We at Moog have not licensed any NASA technologies. I read the NASA e-mails about technology transfer opportunities so I am aware of the types of technologies being offered.

4. "What policy issues should Congress consider to help maximize the economic and societal benefits gained from the nation's investments in NASA and the civil space program?"

   Congress should insist NASA have clear statements of objectives to be accomplished with target dates. I read recently, Professor Steven Squire of Cornell and Chairman of the NASA Advisory Council, spoke about the need for clear, concise mission statements. I am in full agreement.

   Another policy issue is the need for constant, continuous funding to NASA, to the prime contractors and subcontractors such as Moog. As I stated above, the key to advancing technology is to have a technology team working on a continuum of projects. The start-stop recent NASA history is not helpful in building technology teams. Circumstances can certainly change, but awarding contracts and then canceling them is very costly to the overall program and will cause companies to shy away from bidding on NASA work.

My overall conclusion is that NASA has played a very significant role in the development of leading edge technologies. These core technologies and knowledge have enabled much economic growth in the USA, not only in aerospace industries but in many other sectors of the economy who benefit from the new technologies. The model of NASA investing in really hard problems and challenging American companies has enabled the development of many core, pre-competitive technologies. This model is an example of where a Federal investment in technology development has an enormous impact on the overall economy.

Chairman PALAZZO. Dr. Aubrecht, thank you, and I thank the panel for their testimony. At this time I am going to yield as much time as needed to a very special guest who has joined us. He is a Member of the Science, Space and Technology. It is Mr. Ralph Hall of Texas, the Chairman of the full Committee on Science, Space, and Technology.

Chairman HALL. I thank you very much, and I thank you for calling this meeting, and I thank you gentlemen. Is there a lady there? I don't have good eyes. It is probably the one that wrote most of your work for the information you gave us, and I will read and study that on my airplane going back to Texas today.

I won't have any questions, but I will just say that NASA has developed a lot of innovative technologies that weren't supplied and what NASA needs to do, as the last gentleman made some suggestions, I think they need to think about how to use the funds that they are getting. I think NASA has made some pretty desperate decisions in the last three years. Maybe they felt constrained to, but they have thrown money right and left, and when the President ran a line through Constellation, he put us on a road to lose our space station. I know that is not what this is about. This is about new breakthroughs, and we need it, but we need to know how to supply those, and Republicans and Democrats, we are very close together on what we have learned and were doing up to the time Constellation was cast aside. I am not going to comment on that. I think you can tell how I feel about it.

We have advanced aircraft and spacecraft design and technologies that apply to our national security even and certainly to public safety, and if you want to see how we are really treated by the appropriators, just look at figure 4 of R&D in fiscal year 2013 budget request. It goes all the way down to where it looks like we have to pitch some money into the budget. I don't understand the bottom part of that out there. But we are not even keeping pace with inflation. We are in a desperate situation. The last three Presidents did not help us any at all. We have got to pray for this President. I pray for him myself but I looked up the other day and God was rolling his eyes at me, so I don't know if that is anything that is really going to have any effect or not.

But I thank you, Mr. Chairman, for your time. I yield back.

Chairman PALAZZO. Thank you, Mr. Chairman.

I now recognize myself for five minutes for questions. Dr. Peck, in your testimony you mentioned the magazine that you all put out, the spin-off that lists all the success stories through technology transfer and partnerships with small businesses, and I just—on page—and you all don't have to go to this, but on page 84, there is one such small business that actually is in my district in south Mississippi that has partnered with Stennis Space Center. It is called Envision. It is a minority woman-owned business. And the product—and I am not going to go into the details of the product but it is something in our region of the world, emergency response, that is just second nature and they developed a product that has been used in Hurricane Katrina, Ike, Gustav, and it has also been used by the Mississippi National Guard and the EPA most recently in helping to track the oil spill from 2010 in the Gulf of Mexico.

My first question is going to be for Dr. Peck. To what extent did the individual centers develop partnerships with the private sector? What role did the centers play in disseminating technologies available for commercialization and how is that coordinated by NASA headquarters?

Dr. PECK. Well, Congressman, the centers, the field centers of NASA, they really are where the tech transfer happens. Headquarters function is one of leadership and coordination and setting guidance for the field centers in their implementation of the tech transfer policies of the Agency. The individual field centers work closely with local businesses but then also companies around the country to develop these partnerships. There is a number of mechanisms that we use, but I will say that that is the function that resides at the centers and that is why we have those centers because their local expertise is where the strength of NASA's tech transfer program comes from.

Chairman PALAZZO. What is the appropriate balance between Space Technology Program personnel at NASA headquarters and the centers when it comes to effective technology transfer?

Dr. PECK. It is a great question because really the core of the Space Technology Program extends beyond tech transfer, but it is no accident that the Space Technology Program is where the tech transfer function for the Agency really is led. The Space Technology Program, as you know, has a broad mission at the Agency of investing in cross-cutting, pioneering technologies that will ensure NASA's future but then also provide the kind of innovation you have heard discussed here at the panel today.

When the Space Technology Program executes on its work, it combines directed work, which happens at the centers, with competed work where we look for the best ideas wherever they can be found. So there is close to 1,000 projects right now underway thanks to the Space Technology Program. Many of them go through the SBIR/STTR Program, which again you understand is the Small Business Innovation Research and Tech Transfer Research Programs, but a bulk of them also are run through academic institutions in the form of student fellowships and soon faculty support, as well as the more traditional contracts that we associate with new technology projects at NASA through a number of different programs.

The balance of the personnel extends across NASA. There is two issues. There is the issue of what happens within our Innovative Partnerships Office (IPO) where the tech transfer function resides, and there we try to operate a leading function, but there are in fact IPO offices at each center with the responsibility of executing on the tech transfer mission.

In addition to that, though, each center does have a Center Chief Technologist and some staff that are meant to advocate for the center's technology, as well as represent headquarters' guidance throughout their center. So again it is a blend where working together the technology development activity and the tech transfer activity have representation at the centers in terms of staff.

Chairman PALAZZO. All right. Another question for Dr. Peck. In your testimony you mentioned the President's charge to accelerate federal technology transfer activities and indicate where NASA has included such goals in its strategic planning. However, the funding requested for research and development at NASA is barely keeping pace with inflation even as other agencies are reaping the benefits of increased investments. How do you reconcile the increased focus on such activities at the federal level without commensurate funds requested for NASA specifically to meet this challenge?

Dr. PECK. Well, I believe that NASA historically has been very successful in its tech transfer efforts. We have a proud history of that. In fact, of the 4,700 invention disclosures provided by the Federal Government a couple of years ago in 2010, 1,700 came from NASA, so close to a third of the total for across the Federal Government. Our past success, though, we shouldn't rest on those laurels as you suggest; we should take advantage of the IG report and your guidance to really focus our efforts on tech transfer.

There is a number of things we are doing to respond to the Inspector General's report on this. For example, we are rewriting the technology transfer policies to better match current best practices, as well as address commercialization planning. That new policy will provide a streamlined, broad, flexible approach, and that increased coordination will help NASA in best understanding the value of those innovative technological assets.

Policy is part of it, also better training for our personnel. Actually being able to focus our efforts on tech transfer requires that the folks at NASA who do the work in developing new technologies also understand that a commercialization plan is necessary and required. They also need to understand how to submit those so-called New Technology Reports, the NTRs, that actually form the basis of our database of technologies.

Fortunately, now, we have a new website, it is technology.NASA.gov. It is an opportunity for us to reach out very efficiently to the technology community and the community of small businesses and large businesses who want to partner with NASA. There you can find access to all of NASA's past technologies, as well as so-called online partnering tool, which allows for a very rapid turnaround connecting inventors at NASA with opportunities to commercialize them in the private sector.

Chairman PALAZZO. Thank you, Dr. Peck. Although I have some questions for the other members of the panel, I am going to be courteous to my other Members who are here who also have questions. And with the pending votes being called, I will now recognize Mr. Costello.

Mr. COSTELLO. Mr. Chairman, thank you.

Dr. Peck, we have talked about some examples about technologies that have been discovered by NASA and have been commercialized today. I think Members of this Subcommittee and Members of Congress probably know some of the benefits of the work that NASA has done, but there is a tremendous challenge, I believe, in educating the public as to the benefits. Tell us what NASA is doing to improve the public's understanding of the derived technologies and the benefits to the American people and to the world.

Dr. PECK. Well, Congressman Costello, that charge is one of OCT's, the Office of the Chief Technologist. We have a number of approaches we take. There is, of course, the spinoff publication we have talked about already but also a website, again, spinoff.NASA.gov, where folks can see the full history of spinoffs from NASA technology. But it is more than that. Rather than sort of passively waiting for folks to come to our website, we actively engage them through social media. NASA Twitter site has hundreds of thousands of views and that provides us a way to actively engage the public communicating NASA's benefits to them. In addition to that, there is a Facebook presence and blogs, a number of ways that we actively engage through social media, the public on these kinds of issues.

But more than that, you know, when we talk about NASA, we are careful to explain the relevance of what NASA does. So when I am talking about new technology, although I like to delve into the details a lot, I do my best to remind folks that the technology influences everyone's lives. Again, it is no accident that the space program undertakes difficult challenges and those difficult challenges are the ones that create the innovations and the new ideas that drive the Nation's economy. As Dick Aubrecht explained, those are the kinds of ideas that make America unique. In pursuing a space program, we undertake these hard problems that motivate our future and provide success for our businesses.

Mr. COSTELLO. Can you talk a little bit about what you are doing at universities and with teachers? The general public in my opinion, they understand a little bit about the space program. When I am home in my district and when I am traveling, I hear a lot from constituents about we need additional funding for new roads, bridges, highways, for the obvious things that they use in their lives, but I rarely have anyone say to me that you need to put more money into NASA in order to do research and development because they have done all these wonderful things for society. So what are you doing at the common level I would say to educate people at a young age about the benefits that have been derived from NASA?

Dr. PECK. Well, NASA's Office of Education has an extraordinarily success history of outreach to K–12. Within the Space Technology Program, we also have a number of educational activities. They are focused on space technology. One is the Space Technology Research Fellows Program, which provides support for college students studying space technology. It is the first time that NASA has provided this kind of support for students. On top of that, we now also have a Space Technology Research Grants Program that sponsors faculty—similar to the NSF Career Award if you are familiar with that program—that now again introduces the opportunity, which I did not have when I was starting off at Cornell University, to be able to engage with NASA in research in space technology.

The kind of trickle-down effect that we see by sponsoring students and faculty changes the conversation. It makes NASA very present in the lives of our students and it motivates students to pursue STEM activities—that is science, technology, engineering, and math—because the space program quite simply, is exciting.

It is also true of aeronautics. We undertake a lot of fantastic work here that motivates people of all age but particularly students. So I am proud to say that NASA is the reason why a number of students go into STEM and we can keep that going.

Mr. COSTELLO. Thank you. I will have further questions later, Mr. Chairman.

Chairman PALAZZO. I now recognize Mr. Brooks from Alabama.

Mr. BROOKS. Thank you, Mr. Chairman.

Dr. Peck, can you please explain how technologies developed for NASA make their way into other seemingly nonrelated products? And for example, how was the ultrasound device you cite in your testimony a result of NASA research? And was that technology specifically targeted or did it evolve from other research? And do you have any other similar examples you can share with us?

Dr. PECK. Well, Congressman Brooks, the real key to how that happens is our active engagement in technology transfer. We have a technology transfer process and experts at the NASA centers who actively engage with businesses to ensure that NASA technology—which is taxpayer-funded, remember—goes to the private sector and benefits the American economy.

In that particular example, there is a number of mechanisms whereby tech transfer can happen. It can happen simply because a company comes to NASA or we can use our communications techniques to actually seek out companies and find opportunities to transfer that technology. I will offer that the tech transfer pipeline at NASA is full but we can do better to bring new ideas into that pipeline. As the Inspector General's report suggested, we can be doing better to populate that pipeline. But that is just a beginning because, as you suggest, part of how we successfully transfer technologies, how we successfully commercialize involves taking from that next step. Merely inventing is not enough. We have also got to engage with the private sector to do so.

Mr. BROOKS. Well, a follow-up question, how does NASA engage with the entrepreneurial community to ensure potential technologies are recognized and taken advantage of? Are there means of regular discourse with our Nation's technology areas such as Silicon Valley or Research Triangle Park in North Carolina, or Cummings Research Park in my hometown of Huntsville, Alabama, if I could boast for a moment, which is the second-largest research park in the United States of America and the fourth-largest research park in the world?

Dr. PECK. You are absolutely right, sir. NASA actively markets its technology to the technical community at large as not just the area strictly outside of the field center gates. The technology transfer program has an active technology and marketing and outreach campaign. I have described some of the elements of that already. There is also NASA Tech Briefs. This is a free monthly publication, features over 600 NASA technologies per year. It is also the largest circulation engineering periodical in the country. It reaches over 200,000 people per month.

NASA brings its technologies to industry-specific conferences, another method that we use. It brings new sensor technologies to optics conferences, our new composites to manufacturing conferences. The Agency has also recently started hosting industry-specific events like a recent automotive conference in Cleveland to which all the U.S. automakers were invited. And that is to showcase technologies and to test facilities that may be of use to that industry. And we have also got a pilot program in Colorado to determine if regional industrial clusters can benefit from an infusion of NASA technologies.

Some of this work you can read more about at the NASA.gov/OCTeconomicimpacts website, and there is a searchable map where you can see how the investment in SBIR program particularly, maps to local businesses and what do there.

Mr. BROOKS. This question is with respect to the other four witnesses, and whoever wants to grab it first can do so.

How might an entrepreneur view NASA's technologies differently from NASA program managers and innovators? More specifically, is this being taken into account when devising better practices for dissemination of information?

Mr. BECK. I can actually echo some of Dr. Peck's work to give a real example of that. The ultrasound work that was done at the Johnson Space Center I was actually a part of. And one of the things in how these things leverage is the realization and how NASA demonstrates its relevancy to the U.S. populous is NASA has a mission, and because of that mission, it creates a need. We had a need to support our astronaut operators and be able to diagnose illnesses that could occur on orbit.

As a result of that, given the limitations of orbit, a technology was identified using ultrasound to be able to diagnose several of the problems that could occur on orbit. Space is unique but it is also a construction zone. Well, that becomes very relevant because these techniques that were developed in the ultrasound project found their way into being used in ERs on a regular basis in a way that you can be diagnosed in a bed as opposed to having to go off the CAT scan so they can immediately decide whether or not you need surgery. And I have personal knowledge of how the techniques that were developed out of the papers that were published from that program actually led to use directly by our military so that as our special operators, medics fly to save a down pilot or an operator that is remotely deployed and injured, when we get them, we are able to actually diagnose them in time in flight so that we can intervene immediately with a therapeutic intervention. And in addition, we can also have the appropriate care ready for them when they return.

So one of the things that NASA has to do in demonstrating this is make itself more relevant to the public. That is sometimes difficult. Unless you have a panel like this you don't hear about how something is what one would think as unique as ultrasound in space actually has real meaning. The work that was done there was published in a series of over 11 peer-reviewed articles in the medical literature and has really changed the way we provide prehospital care. No one really knows about that and somehow that has to be changed and this Committee offers an opportunity to make that known.

Mr. BROOKS. In that vein, I would like to thank the Chairman for calling this particular hearing. I have been a long believer in NASA perhaps being the premier Federal Government agency that has created technological advances that in turn have made America exceptional. And so, Mr. Chairman, thank you for calling this hearing. I also thank you, witnesses, for helping to share the insight you have been able to share today.

Chairman PALAZZO. I now recognize Mr. Clarke from Michigan.

Mr. CLARKE. Thank you, Mr. Chairman. I appreciate you recognizing me. I represent metropolitan Detroit and I am a Cornell grad, too, so I am really happy to be here today, although in a very non-STEM area, fine arts, painting.

To respond to the question posed by my good friend, the gentleman from Alabama, about the development of the advanced ultrasound devices, that was also facilitated by a partnership with NASA and Henry Ford Health Systems, located in the heart of the city of Detroit. And this is what I wanted to underscore is that NASA recognizes the value that metro Detroit has to commercialize NASA technologies. I appreciate NASA sending out program managers, engineers, and technologists from three NASA centers last year. This is something I encouraged, a greater partnership between NASA and companies in metro Detroit. Also your work with GM in developing robotics technology has been very fruitful.

Detroit has huge capabilities. We have the companies that know how to build and manufacture the best products and technologies that could be sold worldwide. We have got the best-trained people. We have got a lot of people who are out of work who are willing and eager to work. We also have three great research universities, all anchored in the center of Detroit by Wayne State University, along with the University of Michigan and Michigan State University.

Metro Detroit, especially the city, also has the capacity for growth. We have a lot of cheap, vacant land so we could build, let's say, a NASA center for advanced manufacturing research and technology, which is something that I would like to ask NASA to consider down the line.

My point is this: Detroit is ready and open to do business, to do business with NASA. How do you think we can create more metro Detroit jobs by leveraging NASA-derived technologies? That could be to Dr. Peck or to any of the panelists.

Dr. PECK. Well, if I may, Congressman, I will start with an answer to your question. Let me just mention briefly the returns that we see on NASA's investment in technology and how that impacts the country, I mentioned the Spinoff publication a little while ago. Spinoff represents a fraction of all the spinoffs that ultimately result from NASA. The companies surveyed represented in Spinoff, we received about a 50 percent response rate, and from that subset of the subset of all the possible impacts that NASA has had, we found that over just the past decade those investments have created 14,000 jobs through NASA spinoffs, over five billion in revenue, and have saved over 400,000 lives. So the impact of working with NASA on technologies clearly is felt nationwide.

I would offer that specifically for Detroit, there is a nearby NASA center; that is NASA Glenn Research Center. We have piloted an activity there where NASA provides mentorship to local businesses and helps solve technical problems with a small number of NASA expertise hours total, but still, it is a way for them to take what may be a tipping-point technology and turn it into a successful program. It is through the so-called MAGNET program in Cleveland. That is the kind of program that we hope to be able to extend across the Nation. It has been successful so far. I will offer that in the context of Detroit specifically companies that can work with your educational institutions and with NASA can form a three-legged stool of success if you like where the expertise from NASA and from education and from the manufacturing community can be a very powerful combination.

Mr. CLARKE. Thank you, Dr. Peck. What I would like to do is follow up with you and—to see how we can further advance that. You know, we can make that partnership happen. There are a lot of companies that are ready to do business with NASA. I would like to ask one more question.

And how difficult is it for companies to partner with NASA? What barriers do they face in transitioning resulting technologies into commercial products? And what improvements if any would enhance NASA's ability to move more quickly the transition of their ideas into new products? How can we best make the commercialization process more effective and efficient?

Mr. VILJA. I think one of the areas that we can really make strides on if we continue programs to their fruition. You know, one of the things that happens is that you spend a lot of money and effort, and then, before you actually have to put a stamp of completion on it, you stop and then you have to reform, make new teams, and you really never get out to industry with that.

A good example was when the Constellation Program was canceled, the Space Launch System took over many of the systems that carried on from Constellation. The J–2X engine was one of the examples. On its first nozzle, we had a situation where we were coming up with a very complex process for making a very difficult manifold, and that manifold was made of sheet metal and it just wasn't coming together for us. And so we sat around going, well, how are we going to do this? And again in the problem-solving fashion that is derived by NASA to actually make something, we end up going, you know who is really good at stamping sheet metal? Detroit. And we actually went to a company in Detroit and they did a great job. They stamped it out in record time and it was a real neat situation. But if you don't continue the project to the point where you have to bend metal and join metal and actually complete it, you really don't get the full benefit of things.

Mr. CLARKE. Thank you. Yes?

Chairman PALAZZO. Mr. Clarke, would you like to allow Dr. Aubrecht to respond?

Mr. CLARKE. Yes.

Chairman PALAZZO. Okay.

Mr. CLARKE. Thank you, Mr. Chair.

Dr. AUBRECHT. Just coming back to the point that he was making in terms of completing projects, the thing that working on NASA programs allows you to do is to complete the program and demonstrate something, a capability in space. Once you do that, other people are willing to listen to you, but you have to complete the project and have something to show for it. And that is what—my mentioning in terms of green propellants, we have been struggling for five years now trying to get a program to fly green propellants here in the United States. We have been unsuccessful at doing that. Once we do that, we could sell green propellants around the world. It would revolutionize the way satellites are kept in orbit. But you need the initial flight, and NASA is in the position to be able to do that kind of thing. The other commercial guys are very cautious about that because of the risk associated with it. NASA can undertake the risk, demonstrate it. Once you have that, you can take it elsewhere, but you got to complete the project.

Mr. CLARKE. Thank you, Doctor.

Chairman PALAZZO. I now recognize Mr. Rohrabacher from California.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman, and thank you for holding this hearing about the green propellant. Once it is tested and once it is put to use and proven, will it cost more or less than what current——

Dr. AUBRECHT. It would cost a lot less handling hydrazine is hugely expensive. It is not the cost of the fuel; it is the cost of all of the associated support systems that you have to have because it is so toxic. It is dramatically less expensive.

Mr. ROHRABACHER. So then, what we need to do—and I will wait to get the Chairman's attention—is what we need to do is make sure that we provide—Mr. Chairman, his statement about this ultimately being cheaper to go with the green propellant means that we need to be involved in this——

Dr. AUBRECHT. Um-hum.

Mr. ROHRABACHER. —and we need to push this and make sure that it doesn't sit on the shelf.

Dr. AUBRECHT. Yeah.

Mr. ROHRABACHER. And in the end it would be cost-effective for us. So thank you for that.

I would like to ask about your technology—when you were mentioning something that actually creates power at night?

Mr. VILJA. Yeah, what it is is it is a concentrated solar power plant that has a field of about 10,000 mirrors that focuses onto a solar receiver that is on top of a 550 foot tower. It gets the intensity of about 1,000 suns on this receiver. It is a pretty hostile environment but not so bad compared to a rocket nozzle, for instance.

Mr. ROHRABACHER. It doesn't sound like, however, that you would be getting much energy——

Mr. VILJA. Well, we are making——

Mr. ROHRABACHER. —for investment of——

Mr. VILJA. It is actually fairly cost-competitive and what it allows us to do is we run molten salt through the receiver and that molten salt is then put in storage tanks. And now you have a hot reservoir source that you can make steam with throughout the evening. So you can actually get solar power at night and it actually applies toward base load rather than peaking load. And that is a big deal because that is when you start talking about taking coal offline.

Mr. ROHRABACHER. Right. I think if any spinoffs that we have in the future we are going to find that there is a relationship between the energy and what we are developing in space, which leads me to Dr. Peck.

Years ago I was very involved with trying to advocate the development of wireless projection of energy so that we might be able to utilize the satellite as a system of transferring energy from one place in the Earth to the other or collecting it in space and transferring it to Earth. Has there been much research on that or is that just a forgotten project?

Dr. PECK. Congressman Rohrabacher, thanks for bringing that one up. It is an exciting idea and I am glad to report that there are several efforts underway currently at NASA in that particular technology. One is through the NASA Innovative Advanced Concepts Program, which is part of the Space Technology Program within my office. We have a so-called NIAC Phase I study, the Solar Power Satellite via Arbitrarily Large Phase Array—that is SPS–ALPHA. It focuses a modular approach that would one day make a huge orbital platform to be megawatts of wireless power. Now, NIAC is known for those very far-out ideas.

In much more nearer term, we have the Centennial Challenges Program. You may remember this is our flagship prize competition activity. Prizes have often been recognized as a great innovative way to bring in nontraditional offerers and technologists to solve hard problems. We offered a prize for beamed power in 2005 to 2009 looking at how to beam power to a spacecraft that could rise through the atmosphere using that kind of power. In fact, one of the competitors—LaserMotive, LLC—was awarded $900,000 in the 2009 challenge because the practical demonstration of power beaming.

And now, more recently, the game-changing development program, again one of the Space Technology Programs. In 2011, we awarded approximately $3 million for concept studies to multiple companies for a first-phase study called Ride the Light. There was work done by Teledyne Brown Engineering in Huntsville, Alabama; Aerojet in Redmond, Washington; ATK in New York; LaserMotive in Kent, Washington; and a number of others including JPL Boeing and the Aerospace Corporation. These studies show that the cost of a phase 2 ground-based demonstration wouldn't be feasible in the fiscal year 2012 appropriated amount for space technology, but it does provide a path forward for looking into this research in the future.

As you suggest, it is a far-out idea but it has got some promise and this is the sort of thing that we pursue through the Space Technology Program because where else are you going to do it? You know, it has got to be done at NASA.

Mr. ROHRABACHER. Most people don't know we lose a lot of electricity when it goes—when it is transmitted over wires, and come to think of it, is there that much loss when we transmit it by beaming it? And that is the type of studies that I would like to see because it might even be cost-effective to transfer it from space to earth rather than produce it in Earth and using wires to send it thousands of miles away.

One last thought—and I know I just got a few seconds here—and that is we have heard about the sonogram and some of these other spinoff technologies. I am very interested—and we have heard a lot of questions today—about getting the new things onto the market, but if once they are on the market we have private companies that are making lots of money off the jobs that they are doing in the private sector. Is there a payback for NASA? Is there a—who owns the technology? And should we have a system set up so that if someone has a sonogram that becomes used all over the world and

NASA's technology development was instrumental in developing that, who has got the patent and who is going to get the money and is NASA going to get anything back? Maybe Dr. Peck or whoever would like to comment on that.

Dr. PECK. Yes, sir. I will give you a brief response and then maybe save some time for others. You know, briefly, a lot of the tech transfer activity that we have undertaken at the Agency is based on licensing. The licensing fees can come back to the government through that. Part of it goes to the inventor in fact, which motivates——

Mr. ROHRABACHER. Well, we should have that but is NASA getting anything back?

Dr. PECK. Yes, sir.

Mr. ROHRABACHER. We are?

Dr. PECK. And I will take for the record to provide some details on that.

Mr. ROHRABACHER. That would be very nice. That would be very good. Thank you very much.

Thank you, Mr. Chairman.

Chairman PALAZZO. At this time, we are going to go into a second round of questions. We are going to ask our Members to only ask one question just in case votes are called.

And the first opportunity is going to go to Mr. Russell. I think you raised your hand and the question was probably centered around what is the greatest barrier your company faced when working with NASA on technology transfer projects? What was similar to what Mr. Clarke was going to ask you? But we will give you an opportunity and we are going to count that as his question.

Mr. RUSSELL. Thank you. The point I wanted to make was there are some softer aspects of the value of NASA, which is critically important to small companies like mine. So the fact that NASA is using our product allows us to market that fact, which helps NASA and the general public get wider awareness. So that fact that, you know, NASA has used us because they have solved this problem in space for 30 years, that was before people could do remote physiological monitoring due to technology. So when we needed to field it onto special operators, we used NASA's 30-year experience to help us solve that problem for a DOD problem. Then they could take that technology and use it for the washout program on the Air Force and then DHS used that on first responders.

So I think NASA needs recognition that they are using the advanced technology to help other government departments to solve the problem as well. And so then into the general public when our monitoring people at home across the country using that technology, it is very cheap and is now helping everybody in the general public not only be well but monitor their chronic disease issues. So I think the fact that NASA has gone into government departments who had the next need and then into the general public at the consumer level helps NASA. And every time we can tell people where the technology came from, I think that adds a true value back to NASA that is not just financial but helps justify why we are here today and helps the general public back the funding for that next, hopeful that this technology may help in the future.

Whether it is blue sky or deep space general today, I think those are very good examples of how it does come down. And I think that that experience bringing to us and helps our scientists solve problems and excites them to build the competencies of the teams that have been talked about, as well as get that into Best Buy, I think that is a success that helps everybody.

Chairman PALAZZO. All right. Thank you, Mr. Russell.

Dr. Aubrecht and Mr. Vilja, both of you mention in your written testimonies the need for NASA to maintain a clear vision for the future and to continue investing in the hard and challenging technological problems to ensure the United States remains cutting edge. Do either of you have recommendations on ways to improve NASA's strategic vision such as—that the United States is consistently pushing the technological envelope?

Mr. VILJA. Well, I think it is a three-pronged approach. You know, first of all, you really do have to have some sort of sustained production so that you can really get that. By going to a continuous process and proven approach, you really get a draw for what is the technology that you can use.

The second thing is you always have to have a development program going that actually ends up in product. And that is where you really introduce new concepts into practice. And after it has been introduced into practice you know it is practical; you know it is ready for further investment into the commercial spinoff.

But then you also got to keep that third prong going where you are saying, look, what is impossible today? And then start exploring how you make the impossible possible. And that is where you really start getting the breakthroughs. Now, they are not always practical. You know, power beaming is a hard thing to do. But once you start making those initial breakthroughs, then you drive it into practice and then you start getting the commercial spinoff.

So it is really—you have to have a pipeline going and you have to stick to that pipeline because if you keep changing it over, you don't ever really get the full benefit of it.

Dr. AUBRECHT. Yeah, just to extend on that, to me the thing that NASA has done well, where it has succeeded, is when it had a very clear statement in terms of what the objective was on one page. And you need to get NASA on the page, this Committee, the rest of the Congress needs to be on that page, and the White House needs to be on the same page. And it has to be clear. It doesn't have to be very complicated language. It doesn't have to be in scientific or engineering terms or whatever, just a very clear objective in terms of what you are trying to accomplish.

The question earlier in terms of engaging the public and how to get the public understanding what NASA does. You have to write it in terms of what the local newspapers can write articles about that and say here is where NASA is going with something. So to me it is almost a marketing challenge that you have, but it starts with have a very clear, concise statement in terms of what the objective is. And you go back to the manned space program; that is what drove that all the way through the '60s and '70s, which is very clear, continuous, step-by-step here is where we want to go. And to me if you did that with all of the rest of the NASA sort of projects, you would have the same kind of result.

Chairman PALAZZO. Dr. Aubrecht, I think you will find complete agreement with this Committee on what you just said.

And at this time, I will recognize Mr. Costello.

Dr. AUBRECHT. I notice the heads nodding.

Mr. COSTELLO. Thank you, Mr. Chairman.

Mr. Vilja, let me ask you. You mentioned at Pratt Whitney what you have learned and what your experience has been with rocket engines and how it was instrumental in your ability to design a rapid-mix injector. And you talked about the—in your gas fire system. Tell me a little bit, if you will, about how this technology, deploying this new technology in commercial systems, how it may have a result on emission reduction and greater use of coal gasification technology in energy generation?

Mr. VILJA. Sure. I mean the thing that really drives anything into practice is an economic benefit right off the top. By being 90 percent smaller than the other alternatives that exist today, you get a real benefit in just building the plant in the first place, you know, on the order of like 30 percent of building the plant, then a 15, 20 percent reduction in the amount of product that you get out of it for the product you put in.

We are also finding that using this technology we are not as susceptible to the grade of coal coming in. We have been talking to a lot of users of existing plants. They have to specially blend their various coals, and as a rocket guy, had no idea there were that many different coals. But there are a lot of different coals and you have to make a special blend so the gasifiers don't have hiccups and they can still keep producing. Ours seems to be pretty insensitive to that so you can really start using more different grades of coal and still get the same outcome.

Now, by getting the higher efficiency, you get a ten percent lower amount of carbon dioxide that is produced in it and it is coming out at a higher pressure, so if you wanted to do carbon sequestration, you have higher pressure to work with and it is much easier to do that.

And then the final benefit is the fact that since we are a dry-feed system, we use 30 percent less water. And I think over the course of things, water preservation is going to be a very big thing in the environmental agenda, and so I think that I am—you know, a lot of people talk about the air pollution side but we think water conservation is another part of it that makes it economically very attractive.

Mr. COSTELLO. We obviously can't do this now but I will be in touch with you later. I am very interested in pursuing some other questions with you.

Mr. VILJA. That would be great.

Chairman PALAZZO. Thank you. I now recognize Mr. Clarke.

Mr. CLARKE. Thank you, Mr. Chair.

I have been working to attract new companies to metro Detroit. Many of them are startups and virtually all of them are headed up by very bright individuals that understand a partnership with NASA could be mutually beneficial, yet many of them don't understand how to work with government. What steps should a new startup take if they wanted to start a dialogue with NASA on a future likely partnership? And that is to anyone.

Mr. RUSSELL. As a very small company and a foreigner, we started actually when we were based in New Zealand before we shifted the company wholly to the United States, and so we engaged with the end researchers and subject matter experts in NASA that wanted to work with us in a mutually beneficial way. And that really helped us not have to learn the entire SBIR process nor the contracting to begin with. We actually had a value proposition that we could come to NASA and they could help us with the process. And I think there has been some amazing explanation of the processes that exist.

So my recommendation would be figure out what you want to do first and what problem you want to solve rather than head smack into all the bureaucracy that is going to overwhelm you. Because once you have the passion inside NASA and your organization, they are enthusiastic; they will help solve the other problems for you.

Mr. CLARKE. Yes?

Mr. VILJA. NASA has also got an active program where we can have mentor protégé relationships with new companies, particularly in HUBZones or distressed areas, and we have contract flowdowns where a certain percentage of our entire contract value has to go to this kind of a spread. We have had a lot of success on the J–2 program. We had a mentor- protégé relationship with several HUBZone companies where they actually learn how to do government contracting and we were able to bring them into the supplier base. Cain Tubular outside of Chicago had never worked on rocket components. They did a great job on some heat exchanger coils for us. The company in Detroit who was able to stamp out the panels, we think they are going to fall into our supplier base.

But, the intricacies of government contracting is something they are going to have to learn. But these contracts give a great opportunity for them to learn that without having to be overcome by, you know, trying to bid on them individually. And by going along with these kinds of programs, I think that is a great way for them to become part of the NASA supplier base.

Mr. CLARKE. That is great. So I will reach out to you gentlemen, then, regarding some partnerships.

Dr. PECK. May I add something to that?

Mr. CLARKE. Yes.

Dr. PECK. Thank you. Just briefly, I mentioned the online partnering tool already. It is at technology.NASA.gov. That actually allows companies to engage directly with NASA and get handholding through the process. It is actually meant to simplify the kind of relationship that Mr. Russell explained can be overwhelming. But thanks to our new approach and using a web-based interface, we think we are simplifying that. We have even gone further to offer licensing available through the internet, so as a small company, if you know that you want to license a technology that has been developed for NASA, you can go to the website, click on it, and procure it right there and then.

Mr. CLARKE. That is great. So I know I had one question but you actually answered my other questions about licensing. Thank you.

And I yield my time back.

Chairman PALAZZO. Thank you, Mr. Clarke.

I thank the witnesses for their valuable testimony and the Members for their questions. The Members of the Subcommittee may have additional questions for the witnesses and we will ask for you to respond to those in writing.

The record will remain open for two weeks for additional comments and statements from Members.

The witnesses are excused and this hearing is adjourned.

[Whereupon, at 11:23 a.m., the Subcommittee was adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Mason Peck

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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August 16, 2012

Dr. Mason Peck
NASA Chief Technologist
NASA Headquarters
300 E Street SW
Washington, DC 20024

Dear Dr. Peck:

On behalf of the Committee on Science, Space, and Technology, I want to express my appreciation for your participation in the July 12, 2012 hearing entitled, *Spurring Economic Growth and Competitiveness Through NASA Derived Technologies.*

I have attached a verbatim transcript of the hearing for your review. The Committee's rule pertaining to the printing of transcripts is as follows:

> *The transcripts of those hearings conducted by the Committee and Subcommittees shall be published as a substantially verbatim account of remarks actually made during the proceedings, subject only to technical, grammatical, and typographical corrections authorized by the person making the remarks involved.*

Transcript edits, if any, should be submitted no later than August 31, 2012. If no edits are received by the above date, I will presume that you have no suggested edits to the transcript.

I am also enclosing questions submitted for the record by Members of the Committee. These are questions that the Members were unable to pursue during the time allotted at the hearing, but felt were important to address as part of the official record. **Please respond to the enclosed questions by August 31, 2012.**

All transcript edits and responses to the enclosed questions should be submitted to me and directed to the attention of Ben Schell at ben.schell@mail.house.gov If you have any further questions or concerns, please contact Mr. Schell at (202) 225-9011.

Thank you again for your testimony.

Sincerely,

Steven M. Palazzo, Chairman
Subcommittee on Space and Aeronautics

Enclosures: Transcript & Member Questions

Questions for the Record
Chairman Steven Palazzo

Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Space and Aeronautics Subcommittee Hearing
July 12, 2012

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1. Your testimony states that your office is currently reviewing NASA technology transfer policies and will be revising them in the coming year. When will you be able to provide us with the details of those changes?

2. Your testimony mentions a series of internal initiatives aimed at increasing NASA personnel's awareness of the agency's technology transfer policy as a response to the IG's findings. Can you please explain to us what these initiatives are and how will you measure their effectiveness?

Questions for the Record
Representative Dana Rohrabacher

Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Space and Aeronautics Subcommittee Hearing
July 12, 2012

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1. Does NASA receive compensation when it research investment is broadly used as the basis of a new product owned by a private company?

2. Is there payback or benefits for NASA if its technology becomes widely used throughout the world? What about licensing fees?

3. Who owns the technology, patent, or intellectual property rights if a company commercializes a product from NASA R&D investment?

4. Is NASA planning to pursue and demonstrating green propellant in space? If so, what propellants and specify the timeline?

Questions for the Record
Ranking Member Jerry Costello

Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Space and Aeronautics Subcommittee Hearing
July 12, 2012

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1. To what extent can the direct and indirect economic impacts of NASA investments be measured?

2. What has NASA learned over the years, as well as from other Federal R&D agencies, on how to successfully transfer technologies to the commercial sector, and how is NASA acting on those lessons learned?

3. To what extent is commercialization of NASA technologies enhanced by higher funding levels for NASA? What priorities would you address with additional resources?

4. What performance metrics does NASA use to determine the effectiveness of its technology transfer and commercialization activities and individual partnerships, and what is the basis for those metrics?

5. It is not widely known that Zephyr's BioHarnesses monitored miners' wellness during the Chilean mine accident. Mr. Russell's prepared statement indicates that Zephyr is sharing the data collected during those dramatic weeks with NASA. How will that data be useful to NASA and to human exploration specifically?

Questions for the Record
Congresswoman Donna Edwards

Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Space and Aeronautics Subcommittee Hearing
July 12, 2012

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1. What is NASA doing to accelerate technology transfer and commercialization of its research, development, and technology consistent with the direction in the President's Memorandum on "Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses"? When can Congress expect a report documenting the agency's progress towards meeting the President's direction?

2. One of the stated objectives of NASA's Technology Transfer Implementation Plan is to engage the technology transfer process at all stages of development and to ensure that technology transfer is considered at the earliest phases of NASA program and acquisition planning. What will NASA do, in practice, to meet this objective?
   a. To what extent does meeting this goal require a culture shift and, if so, what is the most important thing you are doing to encourage such a shift?

3. In your prepared statement, you say that NASA is "*restoring resources for technology assessments, bridge funding, market analysis, and marketing of technologies.*" What is the justification for NASA's role in market analysis and the marketing of technologies?

Responses by Mr. George Beck

Responses To Additional Questions from Chairman Steven Palazzo

1. How has working with NASA created a new generation of engineers and business owners out of the Impact Instrumentation team? Do you have specific examples of how your partnership with NASA has expanded the pool of promising new commercial technologies and businesses?

   Response:
   Impact Instrumentation, Inc. is a small business and we have to compete against large companies who seek to attract the very best talent. Given this, we have to be creative in how we attract and retain employees. Working with NASA enables us to offer a unique opportunity to our engineers, contribute to a project that will put a device in space. In its own small way the NASA project has helped Impact attract and keep a talented group of engineers and technicians. In so doing this same group has also developed new life support equipment that is used by our military and civilian care providers. In addition, the knowledge in the aerospace community that we are working with NASA has provided a level of validation for our new technology.

2. Once a product is developed and proven as something NASA could effectively utilize "in the field," what is your experience related to getting such a product into the user's hands – how has this differed from our experience with other federal agencies, most notably the Department of Defense?

   Response:

   Projects take a long time to be completed at NASA. This is primarily due to lack of clear direction in the Program. Needs and potential solutions are identified however, the lack of direction results in project moving forward only in an administrative way. We have been working with NASA for almost 10 years and I suspect we will be working with them for another several years before the ventilator is deployed. Our experience with NASA is very different from our experience with our Department of Defense (DoD) and the militaries of other countries. The DoD typically has a defined sense of mission and as a result projects move to completion and fielding much faster.

   This question truly speaks to the future of the manned space program. It is clear that if NASA is to have any future and provide a benefit to our nation that it must have its mission defined and funded. I believe the current funding is sufficient given the economic challenges our nation faces. New leadership is required to work with congress to define manned-space mission followed by a reprioritization of the personnel and resources to meet those mission objectives. Until then, the manned space program will struggle along and waste money as it moves in fits and starts.

Additional Questions for the Record
Ranking Member Jerry Costello

1. Of all the technology transfer and commercialization activities that NASA carries out, which do you consider to have been the most important in facilitating your business growth? Why?

   Response:
   As discussed in session, our technology is being spun into NASA as opposed to a traditional spin off. Our company develops and manufactures medical equipment for military and commercial customers to meet the environmental and operational extremes of prehospital care. We were funded by the Office of Naval Research (ONR) to develop a new integrated medical platform for battlefield casualty care and transport. Knowing that NASA had similar requirements for such a device we subcontracted, using ONR funds as well as our own R&D funds, with NASA's prime contractor for space medicine to do some of the prototype development under our direction. Doing this lead us to form a Space Act Agreement with NASA which facilitated cooperative development. To date the new technology has not been deployed to space but this is more of an issue with loss of direction for NASA than the technology which has completed much of the testing required for use in space. We are able to say this with confidence in that many of our engineers, myself included, worked at NASA and were responsible for developing and clearing equipment for use in space on both the shuttle and space station.

   Business growth, in most instances, I don't believe, that businesses will grow based on a relationship with NASA. For most organizations, outside of the large contractors that do the buld of the work at NASA, working with NASA provides an interesting extension for their existing core technology to meet the challenges of space flight. NASA's influence is much more subtle and cannot be directly measured in dollars. In our case, an emotionless accounting analysis of the project amounts to a ~10 ventilator order with some additional nonrecurring engineering funds in the context of a small business that sells more than 3,000 ventilators per year. However, the project creates an opportunity for our engineers and, at some point, our production personnel to work on something that will go into space. This work creates significant excitement which improves employee retention and increases the pride that they employees and owners have for the company and their work.

   In the larger sense NASA's biggest spin off is and will remain the vision of man, space and exploration. Our nation needs this vision; it's what brings our young people to careers in science and engineering. Our nation also needs the funding that comes from NASA, the DoD and other agencies that support the exploration at the bench in our universities and businesses. NASA doesn't create technology; it creates a need for technology and with that, the person or organization that rises to meet the challenge.

2. How might future partnerships with NASA enable continued technology advancements?

   Response:
   The best partnerships and advancements come when the NASA need is an extension of the current earth-based use of a technology. NASA's support creates the opportunity for businesses to extend their technology to meet the challenge of space and look beyond an immediate focus

to expand their market share with their existing technology. This leads to new technology that can be used in space and terrestrially.

a. What types of partnerships with NASA, in your view, are the most conducive to technology transfer and commercialization?

   Response:
   The best partnerships result when there is a joint need for the end product. In this situation both parties do all that they can to develop the end product.

3. As someone from the private sector, what, in our view, are the biggest barriers to transferring or commercializing NASA-derived technologies?

   Response:
   NASA's ever-shifting priorities and mission focus lead to confusion up and down the chain of command and as a result even the simplest updates or changes are constantly reprioritized because the mission and/or the collective understanding of the mission changes. In the case of a spin off technology the final validation in orbit is delayed and as a result the potential to commercialize the technology is delayed. In our case where we are trying to bring something in, it leads to meeting after meeting with no follow up because the Program isn't sure what it's going to do next.

   The lack of focus and leadership not only effects commercialization it also leads to huge wastes of money and effort as projects are developed and brought close to completion only to be scrapped or "shifted to the right" because the mission goals have changed. This also leads to NASA losing its best employees as the frustrating lack of progress, despite sufficient funding in most cases, leads people to leave for the private sector.

4. Have you engaged in technology transfer with other Federal agencies? If so, how does your experience with NASA technology transfer compare to you experience with other Federal research and development laboratories?

   Response:
   Our company was part of a technology transfer with the DoD where we took a piece of medical transport equipment originally developed by an Army medic. We redesigned the device to make it manufacturable and then brought it into production and distribution. The Special Medical Emergency Evacuation Device (SMEED) is now used by all 4 branches of the military to transport critically ill or injured warfighters from the battlefield through the echelons of care and then back to the United States. Under the program the Army and SGT Smeed receive a royalty from the sale of the device.

Responses by Mr. Brian Russell

Zephyr
Measure Life. . . Anywhere

Congressional Committee Follow on Questions and Answers

19 Sept 2012

Chairman Steven Palazzo

1. The legal dept was easy to work with. Most IP issues were dealt with on normal commercial basis (included with in the commercial product supplied to NASA) or under the Space Act Agreement. Various knowledge was informally exchanged in both directions between Zephyr and NASA personnel to mutual value.
2. The product Zephyr supplies to NASA is under normal commercial terms. Under the Space Act Agreement Zephyr works with NASA to understand research results and sensor performance. Defense Customers require a lot more paper work and generally need customization. This can lead to challenges when the difference in time between design changes and procurement can be multiple years. Special Forces are more dynamic.

Ranking Member Jerry Costello

1. The most value from NASA has come as an informed early adopter and requesting changes based on field use in experiments – e.g. zero gravity flights, pilot fatigue.
2. Future technology developments would require funding into physiological monitoring which does not seem to be a high priority. Possibly bringing NASA in as a subject matter expert with other government departments such as DOD would be mutually beneficial.
3. NASA derived technologies are not required by Zephyr to date. This is some part is due to the difficulty in accessing what is available. Also in the field of Physiological monitoring Zephyr has newer technology than NASA as NASA developments of custom sensors were dropped in the recent past. This is some part shows that the knowledge of the last 30 years has been shared into the general field and the private sector has taken it to larger volume applications benefiting all society. Unfortunately any requests from NASA for NASA specific changes for space would have to be fully funded as the requirements would have no other application. It is good to see the space program adopting WiFi and

BlueTooth off the shelf technologies which will assist NASA (as DOD is doing) to keep up with COTS technology when allowable.

4. Zephyr has licensed technology from US Army. The experience was supported well and very easy.
5. The process was kept simple from Zephyr's perspective as the NASA personnel dealt with all the NASA procedures and requirements.

Responses by Mr. John Vilja

Responses to Questions for the Record
Regarding the Testimony of

John Vilja

Vice-President for Strategy, Innovation & Growth
Pratt & Whitney Rocketdyne
Canoga Park, California

Hearing on

Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Committee on Science, Space and Technology
Subcommittee on Space and Aeronautics
United States House of Representatives

Hearing on 12 July 2012

Reponses provided on 31 August 2012

Questions from Chairman Palazzo:

Question 1: At what point did your company recognize the value of the rocket engine technology to the energy industry? Where was the connection made? What role, if any, has NASA played in that transition?

Response: The value of rocket engine technology within the energy industry was first realized in the late 1970's when Rocketdyne's sister company, Atomics International, was working a number of terrestrial and space energy projects. It became apparent that many of the complex combustion, heat transfer, and fluid modeling models developed for rocket engine design and development were far more advanced than anything being used in the energy sector. As the rocket engine driven multi-disciplinary techniques advanced, so did the collaboration with the energy portion of the company. The synergy became so clear that the rocket and energy segments were combined to create Rocketdyne Propulsion and Power in 1984. Following this, several terrestrial technologies were spun off including hydrogen recombiners for nuclear power plants and waste heat recovery and environmental treatment products. Today, this combination has continued to contribute to the space with the electric power system for the International Space Station and the multi-mission radioisotope thermoelectric generator which powers the Mars rover, Curiosity.

NASA's role in this has been substantial but indirect. By continuing to push the boundaries of rocket propulsion, first by helping create the Space Shuttle Main Engine, then follow-up technologies such as Space Transportation Main Engine, XRS-2200 Aerospike engine, Space Launch Initiative engines RS-83 and RS-84, and even the modernized J-2X currently undergoing development testing, NASA has continued to advance the understanding of many disciplines crucial to furthering technological bounds. Significant increases in understanding have come in the areas of material sciences, thermal management, combustion modeling, high speed rotating machinery, and manufacturing technology. The key is that NASA was not looking for spin-offs, it was reaching forward to conquer new areas of human knowledge and capability. This is the area where they must retain their focus in order to be successful. They have neither the expertise nor the "bandwidth" to attempt to see how their work applies to terrestrial market applications.

Question 2: What avenues does Rocketdyne utilize when seeking opportunities to partner with NASA on non-traditional technology development activities?

Response: Currently all NASA commercial partnering with Rocketdyne is in the area of space launch and utilization. This is done through cooperative agreements where the government and industry agree to collaborate on specific tasks which allow access to NASA facilities and expertise in exchange for payment or information exchange. This avenue is open to use of government assets in support of terrestrial commercial endeavors however these are relatively rare since these agreements require significant effort to initiate and are often not sufficiently schedule responsive for commercial needs. This situation is improving but basic reforms could be useful to provide more efficient commercial utilization of these capabilities.

Questions from Ranking Member Costello:

Question 1: Of all the technology transfer and commercialization activities that NASA carries out, which do you consider to have been the most important in facilitating your business growth? Why?

Response: We do not receive significant benefit from NASA's direct commercialization activities. The benefit we see comes more from expanding the nation's understanding of our physical world by pushing state of the art across multiple disciplines through their space and aeronautical exploration efforts. To better understand this one can compare the outcome from a specific technology development against the benefit from pushing a broader technology imperative. During the 1990's several new material alloys were developed at NASA Research Centers for application in rocket engines. These alloys provided improved life characteristics and better strength at high temperatures. They have yet to find a use in rocket engines due to the high cost of recertification of new materials while they have found little use in commercial industry due to high production costs.

One can contrast that to the parallel development of computational fluid dynamic analytical capability during the same period. By pushing the development and physical anchoring of this methodology, the U.S. has achieved world leadership in application throughout multiple industries. Today, academia and commercial industry has taken a leading role in the advancement of this discipline while NASA still heads the charge in focused areas pertaining to NASA challenges. We see similar trends on other disciplines where NASA has opened the doors and enabled the nation to benefit.

Question 2: How might future partnerships with NASA enable continued technology advancements? What types of partnerships with NASA, in your view, are the most conducive to technology transfer and commercialization?

Response: The greatest contribution NASA provides for continued technology enhancements is in tackling complex, challenging tasks which require the development and integration of new tools, techniques, and technologies. These tasks stretch the state-of-the-art in many disciplines at the same time while creating innovation through the examination of multiple solutions. One example of how this could come from exploration missions to Mars is in solving the issues of transit time. Using traditional propulsion it would take humans 9 months to make the transit. To solve this problem, the nation must develop advanced nuclear thermal or electric propulsion systems and vehicles and must better understand cosmic ray shielding systems and more efficient power and life support systems. Advances in each of the areas involved will be flowed into industry for use in tangential markets. Unfortunately as timelines for tackling these complex challenges are delayed, so is the learning that comes from it.

Question 3: As someone from the private sector, what, in your view, are the biggest barriers to transferring or commercializing NASA-derived technologies?

Response: The biggest challenges we see is in the business side of NASA derived technologies. In order to work with NASA, companies must create elaborate accounting systems and operating procedures to facilitate Government oversight. These systems are effective in creating an environment where the Government can assure its spending is done in a prudent fashion and that technical progress is actually what is being reported.

Unfortunately this has a high overhead cost and few NASA contractors compete well against commercial companies with lower overhead rates and more nimble infrastructures. The way most organizations solve this is to form a separate entity to commercialize a technology. This is effective in that it allows for a commercial infrastructure while enabling the inclusion of tangential industry players to facilitate market understanding. Unfortunately, this tends to mask the benefits derived from the NASA technology and often hides the true benefit of NASA's contribution.

Question 4: Have you engaged in technology transfer with other Federal agencies? If so, how does your experience with NASA technology transfer compare to your experience with other Federal research and development laboratories?

Response: We have worked with several Government agencies outside of NASA in the development of new technology with varying degrees of success. Most notable we have ongoing efforts with the Defense Advanced Research Projects Agency and the Department of Energy. In each case the root cause of success comes from pushing the state-of-the-art to higher levels while maturing the tools to achieve success. Even where the ultimate goal wasn't met, there is significant learning which is returned to the nation as valuable intellectual capital. The pursuit of isolated, singular technology is generally a less productive approach since there is either success or failure with few tangential benefits added to the collective knowledge base.

The most difficult items to commercialize are those technologies created solely within the government agency and offered to industry for commercialization. The challenge here is that industry lacks the innate understanding of the technology which causes the commercial development to be much more costly. This is often an insurmountable barrier to achieve successful commercialization.

Question 5: Could you please elaborate on your recommendation for the creation of a unified national space policy that "recognizes the need for stable production combined with concurrent development of both new products as well as advanced technologies?"

Response: This recommendation is similar to what is being implemented in other nation's space programs. It is even more vital for their efforts since they have much smaller space budgets than the United States. It is a policy that recognizes the ongoing benefit to the nation's knowledge base from the three phases of technology pursuit.

The base of the approach is to have a stable, ongoing production of an advanced product. This creates a basis for continuous process improvement and creates a platform where incremental changes can find application and new workers can hone their skills in real application.

The second leg of this policy is to keep an ongoing full-scale development effort going at all times. This is the phase where the new technologies of greater maturity are harvested and entered into practical service. These technologies are adapted and integrated with other facets of the development to complete the maturation process. Commercialization is most practical after a new technology has been matured through an integrated full scale development effort or after it has been applied to serial production.

The final leg is in the identification and exploration of new technology. This is the process where phenomenology is investigated and potential applications are explored. This usually involves the most experienced subject matter experts exploring the limits of human understanding. The key in this area is to rapidly recognize "failures", document the new found limitation and then quickly move on to the next area of study. Success in these areas has a relatively small yield so it is imperative to keep these efforts from become ongoing legacy sandbox studies. The successful results of this area are the basis for breakthroughs that can open new industries after they have been demonstrated in practical application in the aerospace sector.

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Questions for the Record
Ranking Member Jerry Costello

Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

Space and Aeronautics Subcommittee Hearing
July 12, 2012

1. **How can NASA best encourage and support the development of both incremental and game-changing innovations related to launch vehicles and spacecraft so that these technologies will be accepted in commercial space applications?**

   The commercial space industry is relatively conservative especially in terms of components used on the basic satellite bus. Unless significant improvements are possible with a new design relative to the performance, durability or cost of a component, satellite builders are reluctant to change from the components they have been using. When new technologies or improved designs are possible, there is a role for NASA to provide the financial support and technical collaboration to design, test and fly the innovative designs. This enables the component manufacturer to provide the satellite builders with a proven design with a history of actual usage in space. These improved designs can also be applied on military satellites, and provide similar savings to the DOD.

2. **New innovative materials and fabrication processes could significantly reduce the cost of components for NASA and commercial space applications. How can NASA best encourage and support the development and qualification of materials and fabrication processes?**

   The answer to question 2 is similar to the answer to question 1. The difference is that here the design might be almost identical. The change is in the materials and process to produce the component. A good example of this is the availability of additive manufacturing processes to fabricate metal parts. These processes enable parts to be fabricated that weigh 40-50% less than similar parts made with traditional metal removal manufacturing processes. Here, as with the answer to question 1, NASA has a critical role as the lead user that cannot only provide the seed money, but also the guidance, experience and new specifications to qualify the new materials or processes for satellite usage.

For both questions 1 and 2, the designs, materials and processes are technologies that are not only applicable to other aerospace applications and even commercial and consumer products. Such innovations can make major contributions to America's manufacturing industries.

6. Your prepared statement indicates that Congress should insist on clear statements of objectives with target dates. Can you elaborate on that point and provide examples of where NASA should be directed to provide such definition?

At the mission level, NASA needs to have clear statements of objectives with target dates. These provide the understanding and guidance to the Congress, the NASA staff, the Administration, and the contractors as to what NASA wants to accomplish and the rationale. Perhaps more importantly, these statements should be written so the American media and the American public can understand NASA's relevance. Without the understanding and support of the American public for the missions, NASA cannot expect Congressional support and begins to look like just another jobs program.

At the system or subsystem level, clear statements of objectives with target dates are important to advance the technologies discussed in questions 1 and 2 above. An example is to state its objectives and timetables to develop and fly a fleet of small satellites for NASA. Another example is to do the same relative for green satellite propellants.

Currently, a variety of companies are investing their R&D resources in new technologies like these. However, for the reasons stated above, such technologies are not likely to be widely used without support from government users of satellites, either the DOD or NASA. The advantage NASA has is the level of technical competence to oversee the development, testing and demonstration flights of the new technologies.